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Rework of Electronic Assemblies

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Repair and Modification of Printed Boards and Electronic Assemblies

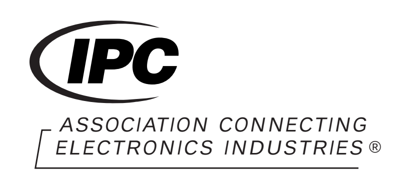
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These standards are now published in a single volume with three sections. Part 1 includes the general information and procedures that are common to both IPC-7711A and IPC-7721A. Part 2 includes all the rework procedures from IPC-7711A and Part 3 includes all the repair and modification procedures from IPC-7721A.

Developed by the Repairability Subcommittee (7-34) of the Product Assurance Committee (7-30) of IPC

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Users of this publication are encouraged to participate in the development of future revisions.

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Acknowledgment

Any document involving a complex technology draws material from a vast number of sources. While the principal members of the IPC Repairability Subcommittee (7-34) of the Product Assurance Committee (7-30) are shown below, it is not possible to include all of those who assisted in the evolution of this standard. To each of them, the members of the IPC extend their gratitude.

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Foreword

These standards are intended to provide information on the rework, repair and modification of printed boards and electronic assemblies. This information must also be supplemented by a performance specification that contains the requirements for the chosen technology. When used together, these documents should lead both manufacturer and customer to consistent terms of acceptability.

These documents supersede the following:

IPC-7711 supersedes IPC-R-700C
IPC-7721 supersedes IPC-R-700C

As technology changes, a performance specification will be updated, or new focus specifications will be added to the document set. The IPC invites input on the effectiveness of the documentation and encourages user response through completion of ‘‘Suggestions for Improvement’’ forms at the end of this document.

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Procedure	Description	Illustration	Product Class	Skill Level	Level of Conformance
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Lifted Land Repair

Procedure	Description	Illustration	Product Class	Skill Level	Level of Conformance
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Land Repair

Procedure	Description	Illustration	Product Class	Skill Level	Level of Conformance
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Procedure	Description	Illustration	Product Class	Skill Level	Level of Conformance
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General Information and Common Proedures

1 General

1.1 Scope This document covers procedures for repairing and reworking printed board assemblies. It is an aggregate of information collected, integrated and assembled by the Repairability Subcommittee (7-34) of the Product Assurance Committee of the IPC.

1.2 Purpose This document prescribes the procedural requirements, tools and materials and methods to be used in the modification, rework, repair, overhaul or restoration of electronic products. Although this document is based in large part on the Product Class Definitions of ANSI/J-STD-001, this document should be considered applicable to any type of electronic equipment. When invoked by contract as the controlling document for the modification, rework, repair, overhaul or restoration of products, the requirements flowdown apply.

IPC has identified the most common equipment and process in order to affect a specific repair or rework. It is possible that alternate equipment and processes can be used to make the same repair. If alternate equipment is used, it is up to the user to determine that the resultant assembly is good and undamaged.

1.2.1 Definition of Requirements The words *must* and *shall* have no special meaning beyond that commonly used in other IPC standards.

1.2.2 Requirements Flowdown The applicable requirements of this document must be imposed by each manufacturer or supplier on all applicable subcontracts and purchase orders. The manufacturer or supplier must not impose or allow any variation from these requirements on subcontracts or purchase orders other than those that have been approved by the user. Unless otherwise specified, the requirements of this document are not imposed on the procurement of off the shelf assemblies or subassemblies. However, the manufacturer of these items may comply as deemed appropriate.

1.3 Background Today's PC boards are more complex and microminiaturized than ever before. Despite this, they can be successfully modified, reworked or repaired if the proper techniques are followed. This manual is designed to help you repair, rework and modify PC boards reliably. The procedures in this document have been obtained from end product assemblers, printed board manufacturers and end product users who recognized the need for documenting commonly used rework, repair and modification techniques. These techniques have, in general, been proven to be acceptable for the class of product indicated through testing and extended field functionality. Procedures contained herein were submitted for inclusion by commercial and military organizations too numerous to list individually. The Repairability Subcommittee has, where appropriate, revised procedures to reflect improvements.

Rework completed satisfactorily will meet the original specification and requirements of IPC-A-600 and IPC-A-610. But, by definition, modifications and repairs do not comply with the initial design or fabrication criteria. For modification and repair, the user must recognize that the criteria in IPC-A-600 Acceptability of Printed Boards and IPC-A-610 Acceptability of Printed Board Assemblies are not necessarily applicable to the procedures herein. Modifications and repairs should not compensate for the lack of proper processes and quality controls. Ultimate cost effectiveness is achieved using appropriate design, fabrication and assembly techniques that minimize the need for modification and repair.

1.4 Controls Although modification, rework and repair procedures may be very similar, the control of such procedures may not be the same, due to the conditions and objectives involved.

1. *Modification*
   The revision of the functional capability of a product in order to satisfy new acceptance criteria.

   Modifications are usually required to incorporate design changes which can be controlled by drawings, change orders, etc. Modifications should only be performed when specifically authorized and described in detail on controlled documentation.
2. *Rework*
   The act of reprocessing non-complying articles, through the use of original or equivalent processing, in a manner that assures full compliance of the article with applicable drawings or specifications.
3. *Repair*
   The act of restoring the functional capability of a defective article in a manner that precludes compliance of the article with applicable drawings or specifications.

Repairs are generally changes to an unacceptable end product to make it acceptable in accordance with original functional requirements. The control of repaired products should be by means of Material Review Board (MRB), or its equivalent, which may consist of Design Engineering, Quality Assurance, and User representatives. The MRB, with technical support, should define the mutually acceptable repair method to be used and take the action necessary to ensure that all applicable procedures are adhered to.

Repair of a failure in the field seldom includes an MRB, and typically is done in accordance with a contract, repair/service order or the user-activity maintenance program requirements. The maximum number of repairs per printed wiring board assembly should be determined by the using activity or agency.

1.4.1 Classification The user of the product is responsible for identifying the Class of Product. The procedure selected for action to be taken (modification, rework, repair, overhaul etc.) must be consistent with the Class identified by the user. The three Classes of Product are:

1. *Class 1 – General Electronic Products*
   Includes products for applications where the major requirement is the function of the completed assembly.
2. *Class 2 – Dedicated Service Electronic Products*
   Includes products where continued performance and extended life is required, and for which uninterrupted service is desired but not critical. Typically, the end use environment would not cause failures.
3. *Class 3 – High Performance Electronic Products*
   Includes products where continued performance or performance-on-demand is critical. Equipment downtime cannot be tolerated, end-use environment may be uncommonly harsh, and the equipment must function where required, such as life support and other critical systems.

1.4.2 Printed Board Types There are a variety of printed board types that the procedures in this document apply to. When selecting the appropriate modification, rework or repair procedure the printed board type being worked should be considered. Select a procedure that applies to the printed board type as listed on the procedure. Printed board types include the following:

R. Rigid Printed Boards and Assemblies
A printed board or assembly using rigid base materials only. These may be single-sided, double-sided or multilayered, and may be constructed from base laminate material that spans all approved commercial grades of laminate and includes glass fabric reinforced epoxy and polyimide resin laminates.

F. Flexible Printed Boards and Assemblies
A printed board or assembly using flexible or a combination of rigid and flexible materials only. May be partially provided with electrically non-functional stiffeners and/or cover lay. These may be single-sided, double-sided or multilayered.

W. Discrete Wiring Boards and Assemblies
A printed board or assembly using a discrete wiring technique to obtain electrical interconnections.

C. Ceramic Boards and Assemblies
A printed board or assembly using ceramic as the base material with interconnections separated by dielectric. The board layers are usually formed by alternate printing or depositing of interconnections and dielectric. The assemblies are either surface mount or die attach. Usually multilayered, these may be single-sided or double-sided.

1.4.3 Level of Conformance Level of Conformance provides the means for selecting an appropriate level of conformance to the original electrical, mechanical, physical, environmental and visual product requirements. Each procedure lists a Level of Conformance that the product will attain when successfully completed.

The Level of Conformance rating for each procedure is based on the skill of the technician. The ratings are based on long term industry experience and are not necessarily backed up with testing data.

1.4.4 Levels of Conformance

L. Lowest Level – Significant variance with the physical character of the original and may vary with many of the electrical, functional, environmental and serviceability factors.

M. Medium Level – Some variance with the physical character of the original and most likely varies with some of the functional, environmental and serviceability factors.

H. Highest Level – Most closely duplicates the physical characteristics of the original and most probably complies with all the functional, environmental and serviceability factors.

Class 3 Products must use procedures rated Highest level unless it can be demonstrated that a lower level procedure will not adversely affect the product's functional characteristics.

Class 2 and 1 Products should use procedures rated Highest level for assured safety and dependability but Medium and Low Level procedures can be used if it has been determined that they are suitable for the specific product's functional characteristics.

Procedures in this manual are given a ''Level of Conformance'' rating which is described in Table 1.

Table 1 Level of Conformance

Functional Consideration	Level of Conformance		
	L	M	H
Electrical - Resistance	No	Verify	Yes
Electrical - Inductance	No	Verify	Yes
Electrical - Capacitance	No	Verify	Yes
Electrical - Cross Talk	No	Verify	Yes
Electrical - High Speed Frequency	No	Verify	Yes
Environmental - Shock	No	Verify	Yes
Environmental - Vibration	No	Verify	Yes
Environmental - Humidity	Verify	Verify	Yes
Environmental - Temperature	Yes	Yes	Yes
Environmental - Altitude	Verify	Verify	Verify
Environmental - Bacteria	Verify	Verify	Yes
Environmental - Fungus	Verify	Verify	Yes
Serviceability - Future Repair or Mod.	No	Yes	Yes

No Procedure may not comply with functional consideration.
Verify Procedure should comply with functional consideration but should be tested to verify.
Yes Procedure will normally comply with functional consideration.

In principle any modification, rework or repair action taken on a product should reestablish the products original character, ''Make it like it was.'' Physical changes, obvious or otherwise, can adversely affect the products performance or capability factors.

1.4.5 Skill Level To assist you in determining the skill level needed for each procedure a Skill Level indicator is included in each process. The Skill Level recommended should be used as a guide only. Skill levels will vary widely from technician to technician and from company to company. These recommendations come from industry experience and are not necessarily backed up with substantive testing. Skills are separated into three categories.

I. Intermediate – Technician with skills in basic soldering and component rework but inexperienced in general repair/rework procedures.

A. Advanced – Technician with soldering and component rework skills and exposure to most repair/rework procedures but lacking extensive experience.

E. Expert – Technician with advanced soldering and component rework skills and extensive experience in most repair/rework procedures.

1.5 Terms and Definitions For terms and definitions refer to IPC-T-50 Terms And Definitions.

1.6 Training The quality and reliability of modified or repaired printed boards and assemblies is highly dependent upon the skill and competence of the person performing these tasks. The implementation of proper methods by unqualified personnel can result in a substandard end product. Consequently, achieving successful results with the methods described herein is predicated on the use of properly trained personnel whose skills have been tested and certified to be of a sufficient level of competence.

1. *Soldering Skills*
   Many companies have considered assembly personnel who are competent in soldering techniques to be sufficiently trained for rework/repair activities. This has often proven to be erroneous, since proper soldering is only one of the skills required. Also, in order to attain comparable results, there are many instances where component rework requires techniques that are different than those used to originally solder the component.
2. *Personnel Selection*
   The proper selection of trainees will contribute significantly toward the success in developing capable repair personnel. Personnel with above average soldering abilities and sound reasoning capabilities often make ideal trainees. However, personnel who have no soldering skills, but possess a good level of eye acuity, manual dexterity, and sound reasoning capability, can be successfully trained.
3. *Professional Training*
   Companies should establish and maintain procedures for identifying the training needs and provide for the training of all personnel performing the activities affecting product quality. Personnel performing specific assigned tasks shall be qualified on the basis of appropriate education, training and experience, as required. Appropriate records of training shall be maintained.

   a. Training for personnel and instructors is commercially available and can be completed by an outside organization specializing in the applicable discipline.
   b. Modification/rework/repair training employs concepts, techniques, procedures and a vocabulary that distinguishes it from basic soldering training.
   c. Effective training requires the development of high levels of comprehension and reasoning within the trainee. This necessitates expansive teaching methods and detailed demonstration under close instructor supervision, to help assure the development of proficiency within each trainee.

   Training to establish a desired level of proficiency can usually be achieved after three to ten days of training, depending on the content of the training program, the complexity of the end product, and the proficiency of the trainee. Testing and certification can be provided for each trainee, as the situation warrants.

1.7 Basic Considerations

1. *Appropriate Approvals*
   Appropriate approvals should be obtained before proceeding with PC board modification, rework or repair. Such approvals should include agreements as to acceptance criteria and limitations.
2. *Singular Procedures*
   Procedures in this book are presented as individual methods. Multiple procedures may be necessary to complete the task.
3. *Quality and Reliability*
   All attempts to modify, rework or repair printed boards and assemblies should seek to equal the quality and reliability of the original, unaltered, end product.
4. *Procedure Selection*
   The procedure selected should be on the basis of optimum end product functionality. Test data should be obtained wherever possible.
5. *Patience*
   To achieve best results, do not rush the process. Keep in mind that most of the cost for fabrication/assembly has already been spent, but with care and patience, most of this cost can be salvaged.
6. *Heat Application*
   Incorrect heat application may cause severe damage to board materials, conductors, components, conformal coatings and solder connections.
7. *Removal of Coatings*
   Coating should be removed from affected areas prior to processing. Coatings will inhibit solder removal and adversely affect resoldering operations.

1.8 Tools and Materials Modification, rework and repair of PC boards and assemblies is generally a highly labor intensive operation relying more on individual operator skills than automation. The use of proper tools and supplies will often have a significant impact on the function and reliability of the end product. To enhance the ease of the task at hand and to improve the potential for a successful operation, the following equipment and supplies are recommended. This list should be used as a guide only.

1. *Proper Workstations*
   A proper workstation; ESD grounded with acceptable lighting, outlets, and configured for comfort is preferable due to the degree of concentration and dexterity required to perform high reliability PC board modification, rework and repair.
2. *High Quality Microscope*
   Precision work generally requires a microscope. Refer to IPC-OI-645 Standard for Visual Optical Inspection Aids for more information.
3. *Lighting*
   Illuminations at the surface of work stations should be 1000 Lm/m^2 minimum.
4. *Soldering Tools*
   Precision soldering is important in today's modification, rework and repair operations. Technicians may need an assortment of special use soldering tools appropriate to the variety of tasks at hand. These tools must be temperature controlled, ESD/EOS safe, ergonomically designed and include a selection of tips to suit each particular operation.
5. *Component Removal and Installation*
   Today's expanding variety of large and small components require an array of special use tools and methods for safe, efficient component removal. These tools generally use either conductive heating (by contact), convective heating (by hot gas) or infrared heating (by focused infrared lamps).

   Each assembly/rework method has certain advantages and precautions depending on the particular Surface Mount Device (SMD) (lead/terminations design, size, body material, etc.), component mounting site (adjacent components, access, substrate type, thermal mass, etc.) and the skill level of the operator.

   For example, chip components addressed in this document have different termination styles including: Bottom, three or five face terminations. Therefore some procedures depicted in this document may not be applicable to all termination styles.
6. *Preheating (Auxiliary) Heating*
   Preheating printed board assemblies is sometimes recommended to avoid thermal shock to temperature sensitive materials and components. Preheating also elevates the thermal mass of the assembly to allow a rework process to proceed in an acceptable time. Preheating can be accomplished using either an oven, heat lamp, hot plate, infrared or convective style heating system.
7. *Fume Extraction*
   Work environments can often expose technicians to potentially hazardous fumes. Disposal and release of certain materials may have a significant environmental impact. The use of localized fume extraction systems, environmental control devices and other personnel protection equipment may be necessary to comply with MSDS requirements and applicable federal, state and local laws.
8. *Hand Held Drilling and Grinding Tool*
   PC Board modification, rework and repair procedures often require drilling, milling or grinding operations. The best type of tool for these delicate operations is

preferably a lightweight, high quality, EOS/ESD controlled motorized rotary tool. This tool can be used for detailed work (i.e., solder resist and conformal coating removal, grinding out burns or laminate defects, drilling out plated holes, cutting fine pitch conductors etc.).

9. *Precision Drill/Mill System*

   Demanding projects often require the need to make very precise holes, slots, groves etc.. Accurate depth control and high speed may be required. A precision drilling/milling system with fixturing to hold the printed board assembly and an attached microscope may be advisable for those unusually demanding projects.

10. *Replacement Conductors and Lands*

    There are commercially available replacement conductors and lands that are normally fabricated from copper foil and plated with solder or nickel and gold for edge contact repair. These conductors and lands are available with or without a dry film adhesive on the back. Adhesive backed conductors and lands are normally heat bonded to the board surface. Replacement conductors and lands are available in hundreds of different shapes.

    Compatible replacement conductors and features may also be salvaged from scrap printed wiring boards, if necessary.

11. *Gold Plating System*

    Plating gold edge contacts or any metal surface requires the use of materials that may have environmental and safety concerns and must be handled properly. The power applied to the plating surfaces must be controlled accurately to expect reliable results. A good plating systems should include; a DC power supply with voltage and current meters, plating anodes sized for gold edge contact plating, a solution tray to collect the solution runoff, a support for the PC board and a tray to hold and store the various chemicals safely.

12. *Epoxy and Coloring Agents*

    Many repair operations require the use of high strength, high temperature epoxies. For high temperature applications two-part epoxies offer the highest strength, thermal resistance and durability. It may also be important to have resists or coloring agents so that you can restore the cosmetic appearance of the board. It is best to cure the epoxies in an oven if possible.

13. *Eyelets and Eyelet Press System*

    Solder plated copper eyelets and an eyelet press/setting tool to repair damaged plated through holes may be required.

14. *Cleaning Station/System*

    Regardless of the Class of Product serviced, a cleaning system that is chemically matched to the flux system(s) in use will be essential to a satisfactory repair. In organizations that perform procedures on Class 3 Products, it may also be necessary to have a cleanliness test system in order to periodically evaluate the ability of the cleaning system to meet the requirements/expectations of the user. Interim or in-process cleaning at the workstation should be used pending completion of the procedure and the final cleaning.

15. *Tools and Supplies*

    Also needed are a wide assortment of hand tools including tweezers, various pliers, files, dental picks, cutting tools and materials such as fluxes, solders, and other common items.

16. *Conformal Coating Area*

    The cost, safety concerns and utility services (air pressure/vacuum, power, venting, UV illuminations, etc.) of equipment associated with both the removal and application of conformal coating suggest to many organizations that one central conformal coating and encapsulant area be installed.

17. *Materials*

    The materials listed are ''generic'' in nature. It is recommended that these materials are available or approved by your company. The use of certain materials includes some increased risk (fire, personnel safety, etc.) and such materials should not be used unless appropriate safety precautions are enforced.

1.9 Process Goals and Guidelines In the three basic processes of **Component Removal, Land Preparation and Component Installation/Replacement**, the fundamental Process Goals and Guidelines are as follows:

Non-destructive Process — During any assembly or rework process, no damage or degradation should occur to the board (both substrate and circuit elements), adjacent components, and the component to be installed or removed. This damage may be either mechanical, thermo/mechanical or purely thermal in nature and may result in either immediate failure, degradation in performance over time (latent failure) or a reduction in reliability.

EOS/ESD damage must also be avoided by employing proper work procedures, work stations and equipment controls.

Controllable, Reliable and Repeatable Process — The process can be employed, and when necessary, modified by a trained operator in a repetitive fashion with consistently acceptable results.

Process Appropriate to Particular Application — The process (or modification thereof) employed is appropriate to the particular application based on the relevant guidelines described below.

Operator Friendly Process — An operator of average ability can, with proper training and practice, become acceptably proficient in employing, and when required, modifying the process to suit any particular requirements of a given task.

Efficient Process — The process can be done repeatedly in a production environment quickly and easily at minimal costs with little or no down-time. Set-up and training time must also be minimal.

1.9.1 Non-destructive Component Removal The particular process goals and guidelines for non-destructive component removal are as follows:

Surface Mount Components

- Pre-/auxiliary heat assembly and/or component if required
- Evenly apply heat in a rapid, controllable fashion to achieve complete, simultaneous reflow (melt) of all solder joints
- Avoid thermal and/or mechanical damage to component, board, adjacent components and their joints
- Immediately remove component from board before any solder joint re-solidifies
- Prepare lands for replacement component

Through-hole Components

Desolder component one joint at a time using vacuum method:

- Pre-/auxiliary heat assembly and/or component if required
- Heat joint in a rapid, controllable fashion to achieve complete solder reflow
- Avoid thermal and/or mechanical damage to component, board, adjacent components and their joints
- Apply vacuum during lead movement to cool joint and free lead

Component removal using solder fountain method:

- Reflow all joints in solder fountain
- Remove old component and either immediately replace with new component, or clear through-holes for component replacement later

1.9.2 Surface Mount Land Preparation Surface mount land preparation should be performed prior to the installation/replacement of a new surface mount component. Avoidance of thermal and/or mechanical damage to the land and substrate is critical.

- The two primary steps include:

1. *Remove Old Solder* — This may be performed with a soldering iron and braided solder wicking material, or with a continuous vacuum ''Flo'' desoldering technique employing a solder extractor and a special tip which allows reflow and vacuum aspiration of the old solder to occur continuously.

2. *Clean Lands* — Old flux residues leftover after the removal of old solder are cleaned in this step prior to adding new solder.

   This step is part of the **Component Installation** process and is accomplished by either prefilling (pretinning) the lands (by reflowing wire solder with a soldering iron or some other heating method), or by applying solder paste (cream) with a dispenser prior to (or after) the component is placed on the land pattern.

   The quantity of solder applied is critical to achieving acceptable joints. For instance, J-lead solder joints require much more solder than gull wing lead solder joints.

1.9.3 Component Installation The particular process goals and guidelines for component installation are as follows:

Surface Mount Components

- Prefill lands or apply solder paste
- Align and place component to lands (tack if necessary)
- Apply solder paste to lead/land area if not applied prior to component placement
- Pre-/auxiliary heat assembly and/or component if required
- Pre-dry applied solder paste
- Reflow solder joints (individually, in groups or all together) with concentrated ''targeted'' heat in a rapid, controllable manner while maintaining lead/land alignment. Joints should remain at target temperature (above melting point of solder alloy) for proper time to achieve optimal intermetallic formation.
- Avoid thermal and/or mechanical damage to component, board, adjacent components and their joints.
- Clean and inspect

Through-Hole Components

- Insert new component into board
- Pre-/auxiliary heat assembly and/or component if required
- Solder joints (individually, in groups or all together) with concentrated ''targeted'' heat in a rapid, controllable manner. Joints should remain at target temperature (above melting point of solder alloy) for proper time to achieve optimal intermetallic formation.
- Avoid thermal and/or mechanical damage to component, board, adjacent components and their joints.
- Clean and inspect

1.9.4 Primary Heating Methods Primary heating methods are those principally responsible for achieving solder reflow during a component installation or removal process. These are to be distinguished from methods used for preheating and auxiliary heating which are employed in addition to primary heating methods in particular situations as described in the **Preheating and Auxiliary Heating** section.

Conductive (by contact) Heating Methods

Handheld conductive heating devices generally fall into one of two categories: Continuously Heated Devices and Pulse Heated Devices, each with their own potential advantages and precautions.

Continuously Heated Devices

Continuously heated devices such as soldering irons, thermal tweezers and thermal pick devices may be held at selected idle tip temperatures prior to use. Continuously heated devices generally (but not always) employ tinnable tips to optimize heat transfer to the work.

Virtually all soldering irons and continuous vacuum solder extractors used for through-hole component installation and removal, respectively, are continuously heated devices.

For surface mount component installation and removal, continuously heated devices offer the following potential advantages:

- Effective at transferring a large amount of heat to a targeted area rapidly
- Can control amount of heat delivery
- Can safely access hard-to-reach places and confine heat to limited areas with proper tip design, selection and use
- Substrate and adjacent components stay cooler during surface mount component installation or removal

With continuously heated conductive heating devices, the following guidelines and precautions should be observed:

- Must utilize a high-efficiency, closed-loop temperature controlled heating handpiece that has sufficient thermal output to keep up with thermal load of the work and duty cycle of the application
- Tip temperature can drop below desired level during heavy, continuous use if handpiece has insufficient thermal output
- Must establish good thermal linkage between tip and joint(s), and use appropriate tip geometry (shape) for effective heat transfer
- Tip and work must be free of oxides and contaminates, and tip must be tinned for effective heat transfer
- Use of external flux or addition of solder sometimes necessary to achieve effective heat transfer
- For surface mount component removal, must often have precise match between tip and component geometry for effective heat transfer to all joints
- Contact may disturb component lead-to-land alignment, especially during SMD re-alignment operations
- May transfer heat too rapidly for use with solder paste or sensitive components
- May obstruct view during alignment and reflow and interfere with joint formation during solder solidification

Pulse Heated Devices

Pulse heated devices such as lap-flow type tools, resistance tweezers and other handheld devices produce heat directly in the tip or work with high current, low voltage power. They are useful for cup terminal soldering and auxiliary heating of connector pins during removal. These devices generally employ low mass, non-tinnable tips which can remain in contact with solder joints as they cool, thereby facilitating proper surface mount component alignment.

Pulse heated devices offer the following potential advantages:

- Effective at transferring a large amount of heat to a targeted area rapidly
- Slim design tips can safely access tight places and confine heat to a limited area
- Can control amount of heat delivery with power setting and dwell time
- Low mass tips heat up and cool down rapidly
- Non-tinnable tips can contact surface mount joint cold, heat to reflow and remain in contact during solder re-solidification to stabilize component alignment
- More gradual heat-up works better with solder paste
- Can correct minor lead non-coplanarity during gull wing SMD installation

With pulse heated devices, the following guidelines and precautions should be observed:

- Less effective means to control heat delivery since handheld devices are generally not temperature controlled
- Must establish good thermal linkage with joints for effective heat transfer (this is more difficult since tips are generally non-tinnable)
- Improper contact may disturb component lead-to-land alignment
- May produce unacceptable residual stress in some stiff leads if not coplanar with lands

Convective (by gas/air flow) Heating Methods

Convective heating methods are generally found in devices such as semi-automated benchtop workstations, high powered handheld hot air guns and nozzle-focused hot air jet handpieces.

Convective heating devices are primarily used for surface mount component installation and removal and offer the following potential advantages:

- Can be used to effectively install and remove components whose solder joints are not accessible, e.g., BGAs (Ball Grid Arrays) and chip components with bottom only terminations.
- Non-contact process which, if used correctly, won't disturb joints or obstruct view
- Can often be used to re-align slightly skewed (misaligned) surface mount components without having to remove first
- External flux or tinning generally not necessary to aid thermal transfer
- Leaves less residue than conductive methods for surface mount component removal
- For surface mount component removal, match between nozzle and component geometry less critical
- Works well with solder paste under most conditions
- Can control amount of heat delivery with:
  - Gas/Air temperature
  - Gas/air flow rate
  - Distance of nozzle from work
  - Dwell time
- Well designed, powerful convective heating devices provide continuous output of heated gas/air at a desired set temperature irrespective of the thermal load of the work and duty cycle of the application

With convective heating devices, the following guidelines and precautions should be observed:

- Must properly focus and control heated gas/air flow to minimize errant heating of substrate, adjacent components and their joints
- Must adequately control exit gas/air velocity (via pressure or flow rate) to avoid:
  - displacement of applied solder paste
  - disturbing the lead/land alignment of surface mount components during installation, and to
  - minimize errant heating
- Heated air flow inefficient means of primary heat delivery when compared to conductive heating methods

1.9.5 Preheating and Auxiliary Heating Methods There are two principal reasons for preheating and auxiliary heating during component installation and removal:

First, preheating is required when there is a risk of thermal shock in the substrate, components or both. The goal is to ''ramp up'' the assembly and/or component at an acceptably safe rate until it reaches a target temperature. The assembly (or component) is then ''thermally soaked.'' This eliminates dangerous temperature gradients which could produce immediate damage, degradation over time or reduction of reliability.

For avoidance of thermal shock, the rate of ''ramp up'' can be critical. For example many ceramic chip capacitor manufacturers have traditionally recommended that preheating occur at a rate of no greater than 2-4 degrees C/sec. until a given minimum temperature is reached.

Second, preheating/auxiliary heating is required when the primary heating method cannot bring all of the solder joints completely up to proper reflow temperature at all or in an acceptable period of time. This may be due to heat sinking by nearby portions of the substrate, circuit elements and adjacent components. The goal is to bring the assembly (or a portion thereof) up to a sufficient (yet safe) temperature at which the rate of heat sinking is low enough that the primary heating device can effect proper solder reflow in an acceptable period of time.

For example, bottom side preheating is often used to speed up a BGA installation and removal process. The primary heat source typically delivers heat (usually convective) only through the top of the component body and it would otherwise take too long before enough heat passes through to the joints causing reflow.

For through-hole desoldering on heavy multilayer boards with internal ground planes, auxiliary heating is often used. This is typically done by positioning a soldering iron tip on the component side of the lead since the tip of the solder extractor may not be able to deliver enough heat to completely reflow the joint prior to activating the vacuum.

Preheating is typically accomplished from the bottom side of the circuit assembly by either a temperature controlled conductive heating plate, a controlled convective heating device, or a system which combines both conductive and convective heating. Controlling both the rate of temperature ''ramp up'' as well as the ''soak'' temperature at which the assembly is held during the primary reflow process is critical to avoiding damage and optimizing the component installation or removal process.

1.9.6 Vision Systems and Surface Mount Component Placement As high lead count, fine pitch SMDs become commonplace, the task of properly aligning and placing these devices during manual SMT rework becomes more challenging.

Appropriate vision systems with sufficient magnification, resolution, field of view and working distance are critical for viewing alignment of component leads to land and monitoring joint reflow during SMD installation.

Vision systems come in various forms including large lenses, stereo microscopes, trinocular microscopes and CCTV (video) systems. While microscopes and lenses are

generally more economical, CCTV systems offer greater ease of use and less operator fatigue, particularly with very fine pitch SMDs. See IPC-OI-645 for further information on optical inspection equipment.

Component handling systems which can adequately establish and maintain X, Y, Z and THETA positioning are also essential for successful alignment and placement during fine pitch SMD installation.

1.9.7 Selecting Optimum Process for Manual Assembly/Rework Other than reasons such as purchase and life cycle costs of equipment, operator training and learning curves as well as other economic considerations, selecting the optimum process for manual assembly/rework depends on a variety of factors. These include:

- Type of component
  - lead (termination) type
  - body composition
- Size of component
- Type of substrate (FR-4, ceramic, etc.)
- Component mounting site
  - thermal mass considerations
  - adjacent components
  - accessibility of component or joints
- Whether the component is being installed or removed
- Whether the component being removed must be salvaged
- Applicable workmanship specifications
- EOS/ESD control requirements

Every manual assembly/rework process and its attendant equipment has advantages and precautions in each particular component installation or removal situation. For this reason, the Procedures contained herein recommend particular processes for each individual component installation/removal situation.

1.9.8 BGA/CSP/Flip Chip Time Temperature Profile (TTP) Because the terminations and connections of BGA, CSP and Flip Chips are under the component, the operator does not have the flexibility to modify the rework procedure in process or visually inspect the end results. To ensure acceptable results of the rework procedure, it is critical to establish a time temperature profile for the rework process. The following steps are needed to achieve an acceptable TTP:

A preheat temperature for both the BGA and Printed Wiring Assembly (PWA) (both ceramic and plastic* BGA's shall be preheated, as shall all PWA's).

***NOTE:** If plastic body or tape bodied components are used, see IPC J-STD-020 (Moisture/Reflow Sensitivity Classification for Plastic Integrated Circuit Surface Mount Devices) for information on moisture sensitivity classification tests, preconditioning, and attachment.

Solder paste characteristics must be identified including viscosity, thixotropy, rheology, deposition thickness and drying time/temperature; or if using flux cored wire solder, land prefill solder quantity and prefill coplanarity required.

Define a cleaning procedure which will meet the end item cleanliness requirements of the customer.

Confirm the destructive physical examination and/or x-ray analysis that the process defined will yield a BGA attachment which meets any quality/reliability requirements imposed.

Define, if used, an accelerated cooling system which does not exceed thermal gradient limits of the most sensitive component of the PWA.

CAUTION: THE TIME TEMPERATURE PROFILE IS DEPENDENT, IN PART, ON AMBIENT RELATIVE HUMIDITY. RELATIVE HUMIDITY VARIATIONS OF GREATER ± 15% FROM THOSE PREVAILING WHEN THE TTP WAS ESTABLISHED MAY REQUIRE MODIFICATION OF THE PROCEDURE DEFINED DURING TTP.

1.9.9 Lead Free Solder The rework of circuit boards assembled using lead free solders are similar to common alloys except as noted below. Proper training needs to be in place to ensure quality and reliability of the assembly. Generally all that is needed is to understand those differences.

Those differences are:

- In most cases the newer alloys will require more time and temperature and one must understand why
- The melting point of the solder alloys are likely to be higher and thus may require a modified flux chemistry
- Wetting times are generally extended
- Solderability indicators such as wetting angles, joint appearance etc., will generally be different
- Higher temperatures and longer dwell times may increase oxidation
- Component lead frames as well as circuit board finishes must be compatible with the solder alloy
- Using alternative means of attachment for rework/repair (such as conductive epoxies) may be advantages due to temperature and other considerations
- For both conductive and convective assembly rework/repair, the use of inert atmosphere (such as nitrogen) should be considered to facilitate the process



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General Information and Common Procedures

Revision: A

Date: 5/02

Number: 2.1

Handling Electronic Assemblies

Product Class: R, F, C, W

Skill Level: Intermediate

Level of Conformance: High

OUTLINE

Electrostatic Discharge (ESD) is the rapid discharge of electrical energy that was created from static sources. When the electrical energy is allowed to come in contact with or even close to a sensitive component it can cause damage to the component. Electrostatic-Discharge Sensitive (ESDS) components are those components that are affected by these high energy surges. The relative sensitivity of a component to ESD is dependent upon its construction and materials. As components become smaller and operate faster, the sensitivity increases.

Electrical Overstress (EOS) is the internal result of a unwanted application of electrical energy that results in damaged components This damage can be from many different sources, such as electrically powered process equipment or ESD occurring during handling or processing.

ESDS components can fail to operate or change in value as a result of improper handling or processing. These failures can be immediate or latent. The result of immediate failure can be additional testing and rework or scrap. However the consequences of latent failure are the most serious. Even though the product may have passed inspection and functional test, it may fail after it has been delivered to the customer.

It's important to build protection for ESDS components into circuit designs and packaging. However, in the manufacturing and assembly areas, we often work with unprotected electronic assemblies that are attached to the ESDS components. This section will be dedicated to safe handling of these unprotected electronic assemblies.

For that purpose, the following subjects are addressed:

2.1.1 Electrical Overstress (EOS) Damage Prevention
2.1.2 Electrostatic Discharge (ESD) Damage Prevention
2.1.3 Physical Handling

Information in this specification is intended to be general in nature. Additional detailed information can be found in EIA-625, Requirements for Handling Electrostatic-Discharge-Sensitive (ESDS) Devices

2.1.1 Electrical Overstress (EOS) Damage Prevention

Electrical components can be damaged by unwanted electrical energy from many different sources. This unwanted electrical energy can be the result of ESD potentials or the result of electrical spikes caused by the tools we work with, such as soldering irons, soldering extractors, testing instruments or other electrically operated process equipment. Some devices are more sensitive than others. The degree of sensitivity is a function of the design of the device. Generally speaking higher speed and smaller devices are more susceptible than their slower, larger predecessors. The purpose or family of the device also plays an important part in component sensitivity. This is because the design of the component can allow it to react to smaller electrical sources or wider frequency ranges. With todays products in mind, we can see that EOS is a more serious problem than it was even a few years ago. It will be even more critical in the future.

When considering the susceptibility of the product we must keep in mind the susceptibility of the most sensitive component in the assembly. Applied unwanted electrical energy can be processed or conducted just as an applied signal would be during circuit performance.

Before handling or processing sensitive components, tools and equipment need to be carefully tested to ensure that they do not generate damaging energy, including spike voltages. Current research indicates that voltages and spikes less than 0.5 volt are acceptable. However, an increasing number of extremely sensitive components require that soldering irons, solder extractors, test instruments and other equipment must never generate spikes greater than 0.3 volt.

As required by most ESD specifications including EIA-625, periodic testing may be warranted to preclude damage as equipment performance may degrade with use over time. Maintenance programs are also necessary for process equipment to ensure the continued ability to not cause EOS damage.

EOS damage is certainly similar in nature to ESD damage, since damage is the result of undesirable electrical energy.

2.1.2 Electrostatic Discharge (ESD) Damage Prevention

The best ESD damage prevention is a combination of preventing static charges and eliminating static charges if they do occur. All ESD protection techniques and products address one or both of the two issues.

ESD damage is the result of electrical energy that was generated from static sources either being applied or in close proximity to ESDS devices. Static sources are all around us. The degree of static generated is relative to the characteristics of the source. To generate energy relative motion is required. This could be contacting, separation, or rubbing of the material.

Most of the serious offenders are insulators since they concentrate energy where it was generated or applied rather than allowing it to spread across the surface of the material. Common materials such as plastic bags or Styrofoam containers are serious static generators and as such are not to be allowed in processing areas especially static safe areas. Peeling adhesive tape from a roll can generate 20,000 volts. Even compressed air nozzles which move air over insulating surfaces generate charges.

Table 1 Typical Static Charge Sources

Work surfaces	Waxed, painted or varnished surfaces Untreated vinyl and plastics Glass
Floors	Sealed concrete Waxed or finished wood Floor tile and carpeting
Clothes and personnel	Non-ESD smocks Synthetic materials Non-ESD Shoes Hair
Chairs	Finished wood Vinyl Fiberglass Non-conductive wheels
Packaging and handling materials	Plastic bags, wraps, envelopes Bubble wrap, foam Styrofoam Non-ESD totes, trays, boxes, parts bins
Assembly tools and materials	Pressure sprays Compressed air Synthetic brushes Heat guns, blowers Copiers, printers

Destructive static charges are often induced on nearby conductors, such as human skin, and discharged into conductors. This can happen when a printed board assembly is touched by a person having a static charge potential. The electronic assembly can be damaged as the discharge passes through the conductive pattern to a static sensitive component. Static discharges may be too low to be felt by humans (less than 3500 volts), and still damage ESDS components. Typical static voltage generation is included in Table 2.

Table 2 Typical Static Voltage Generation

Source	10-20% humidity	65-90% humidity
Walking on carpet	35,000 volts	1,500 volts
Walking on vinyl flooring	12,000 volts	250 volts
Worker at a bench	6,000 volts	100 volts
Vinyl envelopes (Work Instructions)	7,000 volts	600 volts
Plastic bag picked up from the bench	20,000 volts	1,200 volts
Work chair with foam pad	18,000 volts	1,500 volts

2.1.3 Physical Handling

Care must be taken during acceptability inspections to ensure product integrity at all times. Table 3 provides general guidance.

Physical Damage

Improper handling can readily damage components and assemblies (e.g., cracked, chipped or broken components and connectors, bent or broken terminals, badly scratched board surfaces and conductor lands). Physical damage of this type can ruin the entire assembly or attached components.

Contamination

Contamination by handling with bare hands or fingers without some form of protection causes soldering and coating problems; body salts and oils, and unauthorized hand creams are typical contaminants. Body oils and acids reduce solderability, promote corrosion and dendritic growth. They can also cause poor adhesion of subsequent coatings or encapsulates. Lotion formulated specifically for use in solder assembly areas is available. Normal cleaning procedures will not always remove such contaminants. The best solution is to prevent contamination.

Table 3 General Rules for Handling Electronic Assemblies

1. Keep work stations clean and neat. There must not be any eating, drinking, or use of tobacco products in the work area.
2. Minimize the handling of electronic assemblies and components to prevent damage.
3 When gloves are used, they need to be changed as frequently as necessary to prevent contamination from dirty gloves.
4. Solderable surfaces are not to be handled with bare hands or fingers. Body oils and salts reduce solderability, promote corrosion and dendritic growth. They can also cause poor adhesion of subsequent coatings or encapsulates.
5. Do not use hand creams or lotions containing silicone since they can cause solderability and conformal coating adhesion problems..
6. Never stack electronic assemblies or physical damage may occur. Special racks need to be provided in assembly areas for temporary storage.
7. Always assume the items are ESDS even if they are not marked.
8. Personnel must be trained and follow appropriate ESD practices and procedures.
9. Never transport ESDS devices unless proper packaging is applied.

Handling Electronic Assemblies

If no ESDS markings are on an assembly, it still needs to be handled as if it were an ESDS assembly. However, ESDS components and electronic assemblies need to be identified by suitable EOS/ESD labels. Many sensitive assemblies will also be marked on the assembly itself, usually on an edge connector. To prevent ESD and EOS damage to sensitive components, all handling, unpacking, assembly and testing must be performed at a static controlled work station.

Avoid contaminating solderable surfaces prior to soldering. Whatever comes in contact with these surfaces must be clean. When boards are removed from their protective wrappings, handle them with great care. Touch only the edges away from any edge connector tabs. Where a firm grip on the board is required due to any mechanical assembly procedure, gloves meeting EOS/ESD requirements need to be worn. These principles are especially critical when no-clean processes are employed.

Handling After Solder

After soldering and cleaning operations, the handling of electronic assemblies still requires great care. Finger prints are extremely hard to remove and will often show up in conformally coated boards after humidity or environmental testing. Gloves or other protective handling devices need to be used to prevent such contamination. Use mechanical racking or baskets with full ESD protection when handling during cleaning operations.

Common Tools and Equipment

Work environments require tools and equipment to conduct electronic assembly operations. The following information is provided as guidance regarding the use of common equipment. EIA-625 provides more specific information.

NOTES



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General Information and Common Procedures

Revision:

Date: **2/98**

Number: **2.2**

Cleaning

Product Class: R, F, W, C

Skill Level: Intermediate

Level of Conformance: High

OUTLINE

Surface contaminants can significantly effect soldering, bonding, coating and the electrical characteristics of printed board and assemblies. This procedure outlines the cleaning methods for printed wiring boards and assemblies.

REFERENCES

NAWCWPNS Final report for NON-ODS cleaning of electronics and avionics report of October 10, 1995.

BACKGROUND

In the past few years, the Environmental Protection Agency (EPA) has been actively involved in reducing the production of chlorofluorocarbons (CFC's). Through their efforts, and the Montreal Protocol, the production of CFC's have been frozen to 1986 levels with requirements to further decrease to zero production by the year 2000. The London Amendments (June 1990) to the protocol are even more restrictive.

Cleaning of the PCB is an important part of any rework/repair process. The different cleaning processes are dependent upon the type of flux used in the soldering process or the type of contaminate to be removed. A general rule of thumb is ''like dissolves like,'' which is a quick way of saying that usually organic/nonpolar contaminants are best removed by nonpolar solvents and inorganic/polar contaminants are best removed by polar solvents.

A desirable cleaning medium should:

A. Not be harmful to employees or the environment.
B. Possess excellent wetting ability.
C. Dissolve and removes both soluble and particulate contaminants.
D. Be compatible with the PCB assembly.
E. Be stable during use.

INTRODUCTION

If rework/repair operations are performed in a facility that has an automated cleaning systems (i.e., batch, in-line, aqueous, semi aqueous, or solvent), then such equipment should be used to clean the assembly.

If an automated system is not available, the cleaning method that follows should be used to reduce surface contamination prior to using adhesives, coating materials or soldering. A cleaning step after soldering is used to ensure that surface contaminants are not trapped beneath conformal coatings or encapsulants, nor will they contribute to future functional assembly problems.

LIMITATIONS

1. The ability of solvent based cleaning solutions to remove flux residue containing polyglycols should be assessed since not all solvent based cleaning solutions will remove polyglycols.
2. A de-ionized (DI) water rinse should follow IPA/DI cleaning except that a water rinse for double sided printed wiring boards with plated through holes may not be required.
3. Potable (drinking) water should not be used as a final rinse due to the potential of contaminating the printed wiring board assembly with chlorine, fluorine and halides.
4. When automated cleaning is used for assemblies that have been conformally coated, it is important that the cleaning process is compatible with the type of coating used and with any unsealed components. The coating should be checked to ensure that the coating will not be degraded by the cleaning process.

TOOLS AND MATERIALS

Black Light	De-ionized Water (DI)
Brush, Soft Bristles	Gloves
Cleaner, Aqueous or Semi-Aqueous	Isopropyl Alcohol (IPA)
Containers	Oven
	Wipes, Lint Free

PROCEDURE

CAUTION

Use clean gloves during this entire operation.

NOTE

To reduce solvent volumes, mixtures of IPA with water and IPA with solvent are available in pressurized containers. The propellants are HFC's. These containers may be fitted with a bristle brush spray attachments for additional cleaning action.

1. Clean the board in an Aqueous or Semi-Aqueous cleaner, or pour approximately 10 ml per 4 square inches of effected area.

2. Scrub the board vigorously with a continually wet soft bristle brush for 10 seconds.
3. Rinse the area with 10 ml per 26 square centimeters of clean Isopropyl Alcohol to effectively remove all potentially harmful residues.
4. Handle the board by the edges and blot the excess Isopropyl Alcohol with clean, lint free cloth.
5. Examine board visually for cleanliness. The use of a black light will help detect contaminants that will fluoresce.
6. Dry boards in oven, if desired.
7. If the boards or assemblies are to be stored before use or coating, remove them from the oven and allow to cool until they can be handled. Place the boards or assemblies into self sealing bags with packages of desiccant.

EVALUATION

1. Visually examine and test for cleanliness using IPC-TM-650, Test Method 2.3.25 or 2.3.26

NOTES



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General Information and Common Procedures

Revision:

Date: **2/98**

Number: **2.3.1**

Coating Removal, Identification of Conformal Coating

Product Class: R, F, W, C
Skill Level: Advanced
Level of Conformance: High

OUTLINE

This procedure covers the techniques for identifying various coatings so that the appropriate coating removal method can be selected.

Conformal Coating Types IPC-CC-830 has superseded MIL-I-46058 as the primary specification for printed circuit assembly conformal coatings, and covers the following types of conformal coatings:

1. Type AR – Acrylic resin (includes lacquers and varnishes)
2. Type ER – Epoxy resin
3. Type SR – Silicone resin
4. Type UR – Polyurethane resin
5. Type XY – Paraxylylene

REFERENCES

2.1 Handling Electronic Assemblies
2.2 Cleaning
2.5 Baking and Preheating
2.6 Epoxy Mixing and Handling
IPC - CC-830

TOOLS AND MATERIALS

Abrasive Discs	Heated Blade
Brush	Knife
Cleaner	Solvent
Cleaner Wipes	Thermal Parting Tool
Cotton Swab	Wood Stick
Dental Style Drill	

PROCEDURE

To determine the appropriate coating removal procedure the coating must first be identified. During original manufacture the specific coating is usually known. Consequently, the coating removal methods can usually be specified and based on the known coatings being used.

When identification of the coating is not available, simple observation and testing will help identify the coating characteristics so that the proper removal procedure can be specified.

NOTE

The generic or commercial identification of the coating material is not necessary to accomplish coating removal.

1. *Hardness*

   Penetration test in a non-critical area to determine relative hardness. The harder the coating the more suitable to pure abrasive techniques. The softer and gummier the coatings the more suitable to the brushing removal procedures.

2. *Transparency*

   Obviously transparent coatings are usually more suitable for removal than the opaque type. Removal methods used with opaque coatings must be far more controllable and less sensitive to damaging the covered components and printed board surfaces and are usually slower.

3. *Solubility*

   Most coatings are soluble; however, the solvent required to dissolve a specific coating may also attack the board and/or components. Unless directed by other maintenance actions, the solubility test and solvent use should be limited to isopropyl alcohol. Test coat the surface in a noncritical area by brushing on a small quantity and observing the solubility action.

   CAUTION

   Printed board assemblies should not be immersed in harsh solvents.

4. *Thermal Removal*

   Use a thermal parting device with controlled heating and without a cutting edge to determine whether the coating can be thermally removed. Start with a low temperature, approximately 100°C, and increase the temperature until the coating is removed. If the coating flows or gums up, the temperature is too hot or the coating is not suitable for thermal removal.

5. *Stripability*

   Carefully slit the coating with a sharp blade in a non-critical area and try to peel back from the surface to determine if this method is feasible. Due to the adhesion required of coating materials, stripable techniques without chemical aids is usually very limited.

6. Thickness

Coating thickness is determined by visual inspection. Thin coatings show sharp outlines of the components and almost no fillet at intersection points of part leads to the circuit board. Thick coatings reduce these sharp outlines and show fillets where part leads intersect with the board. Coatings thinner than 0.064 cm are considered thin. Coatings thicker than 0.064 cm are classed as thick.

The specific coating to be removed may have one or more of these characteristics and consequently the removal method selected should consider the composite characteristics.

See Figure 1 for Conformal Coating Identification.
See Table 1 for Conformal Coating Characteristics.
See Table 2 for Conformal Coating Removal Methods.

EVALUATION

NOTES

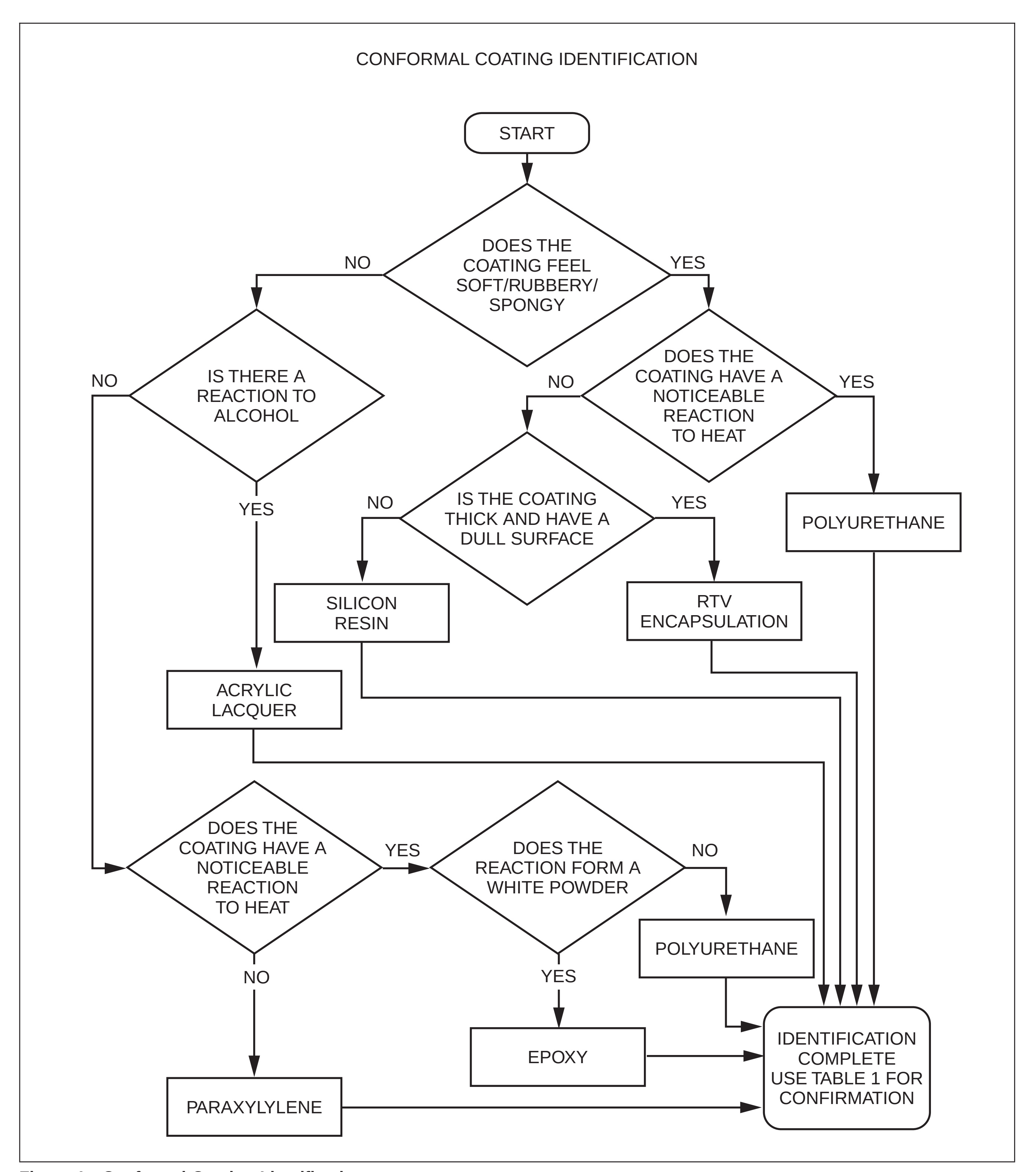


Figure 1 Conformal Coating Identification

Number: **2.3.1**

Subject: **Coating Removal, Identification of Conformal Coating**

Revision:

Date: 2/98

Table 1 Conformal Coating Characteristics

Characteristics	Conformal Coating Type				
	Epoxy	Acrylic	Poly-urethane	Silicone Resin	Para-xylylene
Hard	✓		✓		✓
Medium Hard		✓	✓		
Soft			✓	✓	
Heat Reaction	✓	✓	✓		
Surface Bond - Very Strong	✓			✓	✓
Surface Bond - Strong		✓		✓	
Surface Bond - Medium			✓	✓	
Surface Bond - Light				✓	
Solvent Reaction		✓			
Non-porous Surface	✓	✓	✓		✓
Glossy Surface	✓	✓	✓		
Semi-glossy Surface	✓			✓	
Dull Surface					✓
Rubbery Surface				✓	
Brittle	✓	✓			
Chips	✓	✓			
Peels and Flakes		✓	✓		✓
Stretches			✓	✓	
Scratch, Dent, Bend, Tear			✓	✓	✓

Table 2 Conformal Coating Removal Methods

Conformal Coating	Removal Method				
	2.3.2 Solvent Method	2.3.3 Peeling Method	2.3.4 Thermal Method	2.3.5 Grinding Scraping Method	2.3.6 Micro Blasting Method
Paraxylyene			1	2	3
Epoxy			1	2	3
Acrylic	1		2	3	4
Polyurethane	3		1	2	4
Silicone Thin	1		2	3	4
Silicone Thick		1		2	

NOTE: The preferred order for applying removal methods to specific coatings is numerically indicated. These removal methods are listed in ascending order. More than one method may be required.



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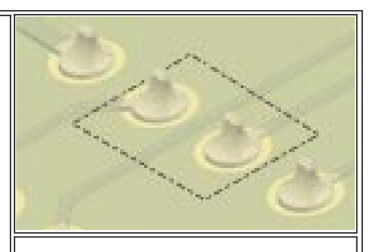
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Revision:

Date: 2/98

Number: **2.3.2**

Coating Removal, Solvent Method



Product Class: R, F, W, C
Skill Level: Advanced
Level of Conformance: High

OUTLINE

This procedure uses a solvent to remove surface coatings. This procedure can be use for spot or overall coating removal of conformal coatings or solder resists.

Approved solvents may be used to remove specific soluble type coatings on a spot basis by brushing or swabbing the local area with the controlled application of solvent until the area is free of the coating material.

If warranted, all the soluble type coating can be removed by immersing and brushing the entire printed board or printed board assembly.

To determine the appropriate coating removal procedure the coating must first be identified. Refer to procedure number 2.3.1.



Figure 1 Apply tape to outline for coating removal.



Figure 2 Apply solvent with foam swab to remove coating.

NOTE

Coating removal may require the use of one or more methods.

CAUTION

Determine, on a module by module basis, the hazards to parts, etc., by short term immersion in the removal solvents. If chloride based or other harsh solvents are used, extreme care must be exercised to prevent damage to base material, component parts, plated-through holes, and solder joints. Some solvent coating removal methods can cause expansion or swelling of the base material which can degrade the printed board or printed board assembly. Under no circumstances should these solvents be used except in a closely controlled process. It is recommended that the printed board or printed board assembly be inspected to ensure that no damage has occurred.

Before using any solvent refer to Material Safety Data Sheets.

REFERENCES

2.1 Handling Electronic Assemblies
2.2 Cleaning
2.3.1 Coating Removal, Identification of Conformal Coatings
2.4.1 Coating Replacement, Solder Resist
2.4.2 Coating Replacement, Conformal Coatings/Encapsulants

TOOLS AND MATERIALS

Brush	Suitable Solvent
Cotton Swab	Thermal Parting Tool
Polyimide Tape	Wood Stick
Knife	

Number: **2.3.2**	Subject: **Coating Removal, Solvent Method**
Revision: Date: 2/98	

PROCEDURE – LOCAL SPOT REMOVAL

1. Apply Polyimide tape to outline the area where the coating needs to be removed. (See Figure 1.)
2. Dip the end of a foam swab in stripping solution and apply a small amount to the area of coating to be removed. (See Figure 2.)

   As an alternative, a small cotton patch can be cut to the size of the area masked (see Figure 1), saturated with the stripping solution, and pressed into intimate contact with the surface of the coating to be removed. The patch will retard the evaporation of certain solvents and reduce exposure time.

   NOTE
   Since various substances may be used as coatings, the time required for a given coating to dissolve or soften will vary. Reapply solvent several times as most solvents evaporate rapidly.
3. Rub the treated surface carefully with a brush or wood stick to dislodge the coating. A wedge shaped applicator tip, knife, or heated blade may be effective in removing some coatings, particularly polyurethanes.
4. Neutralize or clean the stripped area and dry.

PROCEDURE – OVERALL REMOVAL

1. A single step for removal of all the coating may be completed by providing a continuous flow of solvent.

   Alternately, process the board in a series of tanks containing mild solvent, starting with a high contamination tank and progressing sequentially to a final, fresh solvent tank.

EVALUATION

1. Visual examination or UV light may be used to verify complete removal of coating.

NOTES

Coating Removal Required at Outlined Areas



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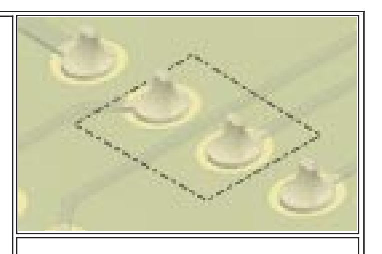
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Revision:

Date: **2/98**

Number: **2.3.3**

Coating Removal, Peeling Method



Product Class: R, F, W, C
Skill Level: Advanced
Level of Conformance: High

OUTLINE

This peeling removal method for coating can be used only under special circumstances. Normally this method is used to remove RTV silicone or other thick rubbery-like coating materials.

The coating material is removed using a dull knife or otherwise dull blade to slit the coating material and to peel it off the printed board or printed board assembly.

To determine the appropriate coating removal procedure the coating must first be identified. Refer to procedure number 2.3.1.

NOTE

This method is limited to coatings that are rubbery in nature to allow the coating material to be slit into small sections and peeled off the printed board assembly.

REFERENCES

2.1 Handling Electronic Assemblies
2.2 Cleaning
2.3.1 Coating Removal, Identification of Conformal Coatings
2.4.1 Coating Replacement, Solder Resist
2.4.2 Coating Replacement, Conformal Coatings/Encapsulants

TOOLS AND MATERIALS

Heated Blade
Knife
Wood Sticks

PROCEDURE

1. Slit and peel off the coating material with a dull knife or heated dull blade. (See Figure 1.)
2. Repeat as needed until the required material is removed.

EVALUATION

1. Visual examination or UV light may be used to verify complete removal of coating.

NOTE

Coating Removal Required at Outlined Area

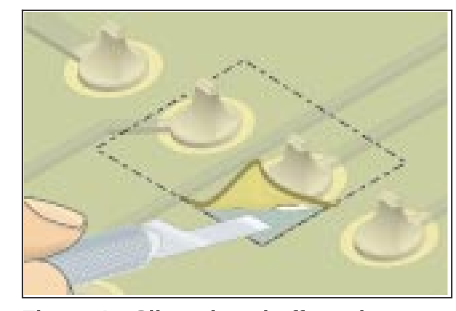


Figure 1 Slit and peel off coating using a knife or heated blade.

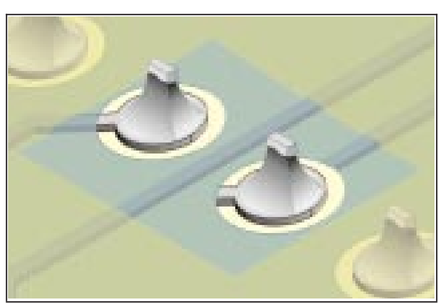


Figure 2 Removal complete.

Number: **2.3.3**	Subject: **Coating Removal, Peeling Method**
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NOTES



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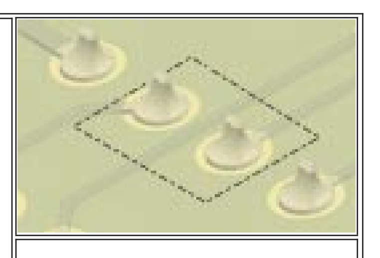
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Revision:

Date: **2/98**

Number: **2.3.4**

Coating Removal, Thermal Method



Product Class: R, F, W, C
Skill Level: Advanced
Level of Conformance: High

OUTLINE

This coating removal procedure uses a controlled, low temperature, localized heating method for removing thick coatings by an overcuring or softening means.

Two methods are covered. The first method uses various shaped, temperature controlled tips, with dull edges to soften and remove the coating.

The second method uses a localized controlled jet of hot air or inert gas to soften the coating material which is pushed away or removed by a non-marring tool.

These methods do not burn or char either the coating or printed board.

CAUTION

Soldering irons should not be used for coating removal as their high operating temperatures will cause the coatings to char and possibly delaminate the printed board base material.

The use of thinned down soldering iron tips or soldering iron heated thin cutting blades are not recommended since they do not provide controlled heating and may present dangerous sharp edges to the workpiece surface.

To determine the appropriate coating removal procedure the coating must first be identified. Refer to procedure number 2.3.1.

REFERENCES

2.1 Handling Electronic Assemblies
2.2 Cleaning
2.3.1 Coating Removal, Identification of Coatings
2.4.1 Coating Replacement, Solder Resist
2.4.2 Coating Replacement, Conformal Coatings/Encapsulants

TOOLS AND MATERIALS

Brush	Knife
Heated Blade or Thermal Parting Tool	Small Cutters
Hot Air Tool	Wood Sticks

PROCEDURE - THERMAL PARTING METHOD

1. Select an appropriate thermal parting tip to suit the workpiece configuration. Set the nominal tip temperature, using the manufacturer's recommended procedure.
2. Apply the thermal parting tip to the coating, using a light pressure. The coating material will either soften or granulate. Polyurethanes will soften and epoxies will granulate. The tip temperature should be regulated to a point where it will effectively ''break down'' the coating without scorching or charring. (See Figure 1.)



Figure 1 Apply thermal tip to soften or granulate the material.



Figure 2 Apply hot air to the work area and remove overcured coating.

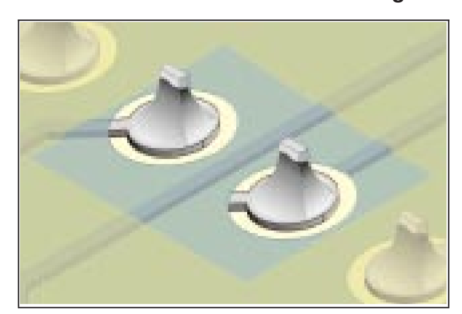


Figure 3 Removal complete.

3. Gradually reduce the coating thickness around the component body without contacting the board surface. Remove as much coating as possible from around component leads to allow easy removal of the leads.
   Clip leads of component parts that are known to be faulty, thus permitting removal of the part body separately from leads and solder joints. Low pressure air or a brush should be used to remove the loosened coating.
4. Once sufficient coating has been removed, leaving only a small bonded joint between the part body and printed board, heat the component body with the thermal parting tool or hot air jet to weaken the bond beneath the component.
5. Lift the component body free of the printed board using small pliers.

   NOTE

   Twist the component prior to removal to shear any remaining epoxy bond to the printed board surface.
6. Once the component body has been removed from the board surface, the remaining coating material can be removed by additional thermal parting. The remaining leads and solder joints are then removed by appropriate solder extraction means.

PROCEDURE - HOT AIR METHOD

By control of the gas/air temperature, flow rates and jet shape, the hot air method can be applied to almost any workpiece configuration on both the component and solder side of the printed board without damage.

Extremely delicate work can be handled in this manner while permitting direct observation of the heating action.

1. Set up the hot air tool per the manufacturer's instructions. Adjust flow rate and temperature to suit specific coating removal application.

   CAUTION

   Never set the gas/air temperature at a level that will cause scorching or charring of the coating material or reflow the solder connections.
2. Apply the heated air jet to work area. Apply light pressure using a wood stick or other non marring tool to remove the softened or overcured coating. All coating around individual leads, solder joints and component bodies can be removed in this manner. (See Figure 2.)
3. When the coating has been removed, use appropriate solder extraction method to remove components if needed.

EVALUATION

1. Visual examination or UV light may be used to verify complete removal of coating.

NOTES

Coating Removal Required at Outlined Area



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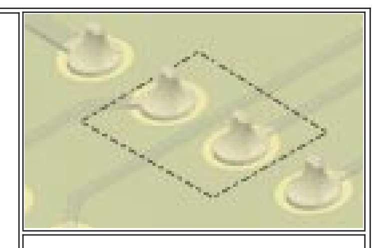
General
Information and
Common Procedures

Revision:

Date: **2/98**

Number: **2.3.5**

Coating Removal, Grinding/Scraping Method



Product Class: R, F, W, C
Skill Level: Advanced
Level of Conformance: High

OUTLINE

This coating removal method uses various grinding and scraping tools, depending on the composition of the coating material. A knife or dental style scraper is normally used when a scraping method is desired. A hand held drill is normally used when a grinding technique is desired. A wide variety of rotary abrasive materials including ball mills may be required.

To determine the appropriate coating removal procedure the coating must first be identified. Refer to procedure number 2.3.1.

CAUTION

Abrasion operations can generate electrostatic charges.

REFERENCES

2.1 Handling Electronic Assemblies
2.2 Cleaning
2.3.1 Coating Removal, Identification of Conformal Coatings
2.4.1 Coating Replacement, Solder Resist
2.4.2 Coating Replacement, Conformal Coatings/Encapsulants

TOOLS AND MATERIALS

Ball Mills	Microscope
Brush	Rubberized Abrasives
Cleaner	Scraper
Cleaning Wipes	Wood Sticks
Hand Held Drill	Rubber Eraser
Knife	

PROCEDURE - SCRAPING

1. Clean the area.
2. Remove the damaged or unwanted coating or solder resist using a knife or scraper. Hold the blade perpendicular to the coating and scrape from side to side until the desired material is removed. (See Figure 1.)
3. Remove all loose material and clean the area.

PROCEDURE - GRINDING

1. Clean the area.
2. Insert an abrasive tip into the hand held drill. Abrade away the damaged or unwanted coating. Move the tool from side to side to prevent damage to the printed wiring board surface. (See Figure 2.)
3. Remove all loose material and clean the area.

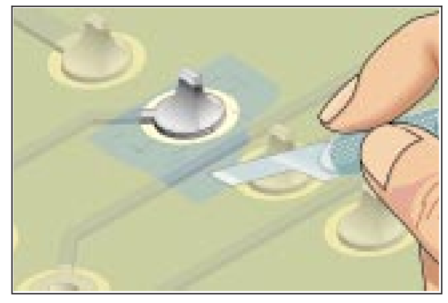


Figure 1 Scrape away damaged or unwanted coating.



Figure 2 Rubberized abrasives used to remove thin, hard coating.



Figure 3 Rotary brushes are best used to remove soft coating.

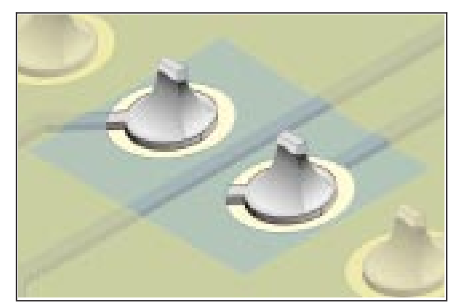


Figure 4 Removal complete.

Number: **2.3.5**	Subject: **Coating Removal, Grinding/Scraping Method**
Revision: Date: 2/98	

NOTE

Rubberized abrasives of the proper grade and grit are ideally suited for removing thin hard coatings from flat surfaces but not for soft coatings since these would cause the abrasive to ‘‘load up’’ with coating material and become ineffective.

Rotary brushes are better suited than rubberized abrasives on contoured or irregular surfaces, such as soldered connections, etc., since the bristles will conform to surface irregularities while removing hard or soft coatings. (See Figure 3.)

NOTE

The procedure for removing thick coatings is primarily to reduce their thickness to a thin coating and then to remove the remaining thin coating by the scraping method.

EVALUATION

1. Visual examination or UV light may be used to verify complete removal of coating.

NOTES



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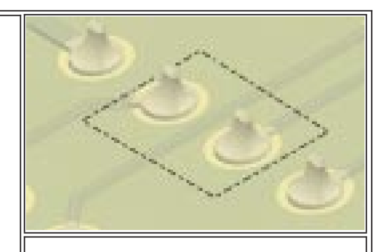
General Information and Common Procedures

Revision:

Date: 2/98

Number: 2.3.6

Coating Removal, Micro Blasting Method



Product Class: R, F, W, C
Skill Level: Advanced
Level of Conformance: High

OUTLINE

This coating removal method uses a micro abrasive blasting system and a very fine soft abrasive powder. The powder is propelled through a small nozzle toward the area where the coating needs to be removed.

To determine the appropriate coating removal procedure the coating must first be identified. Refer to procedure number 2.3.1.

CAUTION

Micro blasting will generate substantial static charges. The work area should be flooded with ionized air and the printed wiring board assembly should be grounded whenever possible.

REFERENCES

2.1 Handling Electronic Assemblies
2.2 Cleaning
2.3.1 Coating Removal, Identification of Conformal Coatings
2.4.1 Coating Replacement, Solder Resist
2.4.2 Coating Replacement, Conformal Coatings/Encapsulants

TOOLS AND MATERIALS

Abrasive Powder
Polyimide Tape
Micro Blasting System
Removable Mask
Stencils

PROCEDURE

1. Clean the area.
2. Select the appropriate abrasive blasting powder and nozzle size. Set the air pressure at the desired setting per equipment manufacturer's instructions.
3. Apply polyimide tape or other masking material to protect the printed wiring board surface as needed. (See Figure 1.) Masking materials can consist of tapes, curable liquid masks or reusable stencils.
4. If the printed wiring board has static sensitive components, insert the entire printed wiring board into a shielded bag. Only the area needing rework should be exposed. Ground the printed wiring board to dissipate static charges if needed.
5. Insert the printed wiring board into the blasting chamber and blast away the damaged or unwanted coating or solder resist. Slowly move the nozzle along the area where the coating is to be removed. (See Figure 2.)
6. Blow off the blasting dust and clean the area.

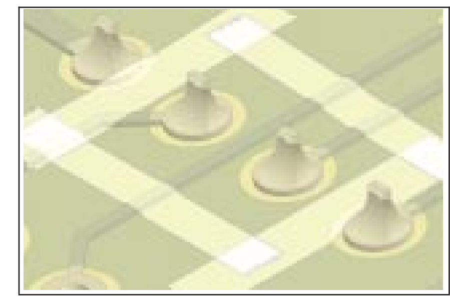


Figure 1 Apply tape to outline area for coating removal.



Figure 2 Remove coating using micro blasting system.

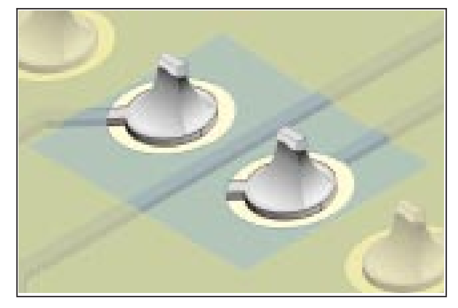


Figure 3 Removal complete.

Number: **2.3.6**	Subject: **Coating Removal, Macro Blasting Method**
Revision: Date: 2/98	

EVALUATION

1. Visual examination or UV light may be used to verify complete removal of coating.

NOTES



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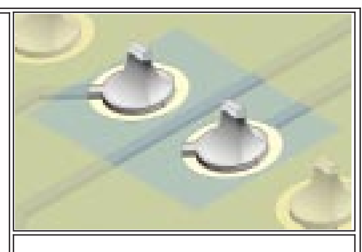
General Information and Common Procedures

Revision:

Date: 2/98

Number: 2.4.1

Coating Replacement, Solder Resist



Product Class: R, F, W, C

Skill Level: Intermediate

Level of Conformance: High

OUTLINE

This method is used to replace solder resist or coatings on printed wiring boards. Most replacement coatings can be applied by dipping, brushing or spraying.

REFERENCES

2.1 Handling Electronic Assemblies
2.2 Cleaning
2.5 Baking and Preheating
2.6 Epoxy Mixing and Handling

TOOLS & MATERIALS

Cleaner
Cleaning Wipes
Color Agent, Various Colors
Brush
Epoxy or Replacement Coating
Foam Swab
Heat Lamp
Microscope
Oven

PROCEDURE

1. Clean the area.

   CAUTION
   Surfaces to be coated must be thoroughly cleaned prior to coating to ensure adequate adhesion, minimized corrosion, and optimized electrical properties.

2. If needed, apply Polyimide tape to outline the area where the solder resist will be applied. (See Figure 1.)
3. Mix the epoxy or replacement coating. If desired, add color agent to the mixed epoxy to match the printed wiring board color.
4. Apply the replacement coating to the board surface as required. A brush or foam swab may be used to apply and spread the epoxy or replacement coating. (See Figure 2.)
5. Cure the replacement coating per the manufacturer's instructions.

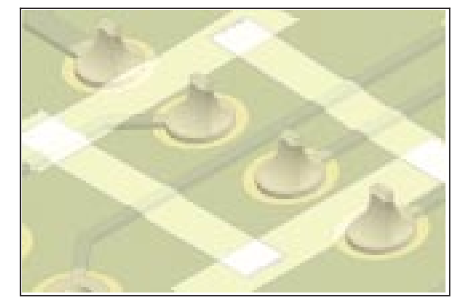


Figure 1 Apply polyimide tape if needed.

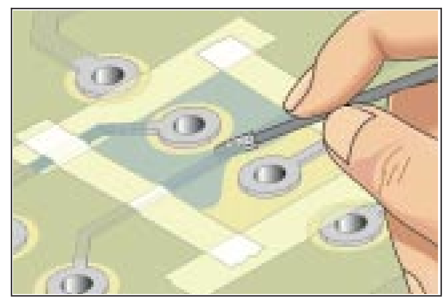


Figure 2 Apply replacement coating with a foam swab to create a texture.

CAUTION

Some components may be sensitive to high temperature.

EVALUATION

1. Visual examination for texture, color match, adhesion and coverage.
2. Electrical tests to conductors around the repaired area as applicable.

Number: **2.4.1**	Subject: **Coating Replacement, Solder Resist**
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NOTES



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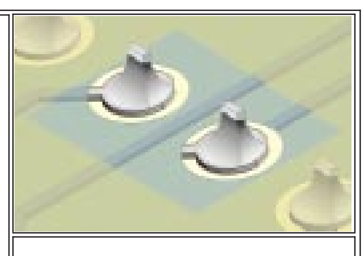
General Information and Common Procedures

Revision:

Date: 2/98

Number: **2.4.2**

Coating Replacement, Conformal Coatings/ Encapsulants



Product Class: R, F, W, C
Skill Level: Intermediate
Level of Conformance: High

OUTLINE

This method is used to replace conformal coatings and encapsulants on printed wiring boards.

REFERENCES

2.1 Handling Electronic Assemblies
2.2 Cleaning
2.5 Baking and Preheating
2.6 Epoxy Mixing and Handling

TOOLS & MATERIALS

Cleaner	Foam Swab
Cleaning Wipes	Heat Lamp
Brush	Microscope
Epoxy or Replacement Coating	Oven

PROCEDURE

1. Clean the area.

   CAUTION
   Surfaces to be coated must be thoroughly cleaned prior to coating to ensure adequate adhesion, minimized corrosion, and optimized electrical properties.
2. If needed, apply Polyimide tape to outline the area where the coating will be applied. (See Figure 1.)
3. If required, bake the printed wiring board prior to the application of the replacement coating.
4. Mix the replacement coating.
5. Apply the replacement coating to the board surface as required. A brush or foam swab may be used to apply and spread the replacement coating. (See Figure 2.) For large surfaces, apply the replacement coating with a foam swab to create a texture.
6. Cure the replacement coating per the manufacturer's instructions.

CAUTION

Some components may be sensitive to high temperature.

EVALUATION

1. Visual examination for texture, color match, adhesion and coverage.
2. Electrical tests to conductors around the repaired area as applicable.

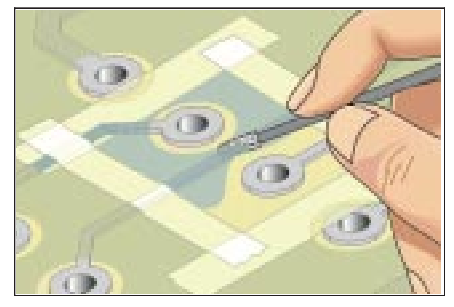


Figure 1 Apply replacement coating with foam swab to create a texture.

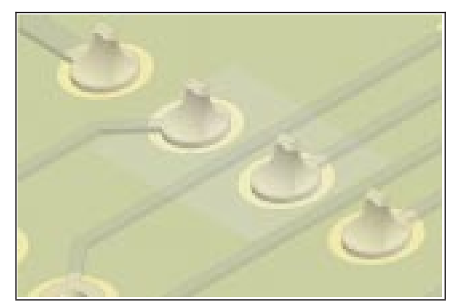


Figure 2 Repair complete.

Number: **2.4.2**	Subject: **Coating Replacement, Conformal Coatings/Encapsulants**
Revision: Date: 2/98	

NOTES



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General
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Revision:

Number: **2.5**

Date: **2/98**

Baking and Preheating



Product Class: R, F, W, C
Skill Level: Intermediate
Level of Conformance: High

OUTLINE

This procedure covers baking and preheating of printed boards and printed board assemblies to prepare the product for the subsequent operations. Included are steps for:

A. Baking

Baking is used to eliminate absorbed moisture. Whenever possible printed wiring boards and printed wiring board assemblies should be baked prior to soldering, unsoldering and coating operation to prevent blistering, measling or other laminate degradation.

B. Preheating

Preheating is used to promote the adhesion of subsequent materials to the board surfaces and to raise the temperature of the printed wiring board to allow soldering and unsoldering operations to be completed more quickly.

CAUTION

Baking and preheating procedures must be carefully selected to ensure that temperature and time cycles used do not degrade the product. Environmental conditions must also be carefully considered to ensure that vapors, gases, etc., generated during the heating process do not contaminate the product's surfaces.

CAUTION

To prevent fluxes or other contaminates from being baked onto the board surface, thoroughly clean the board or assembly prior to baking or preheating.

REFERENCES

2.1 Handling Electronic Assemblies
2.2 Cleaning

TOOLS & MATERIALS

Cleaner
Cleaning Wipes
Oven

EVALUATION

Number: **2.5**	Subject: **Baking and Preheating**
Revision: Date: 2/98	

NOTES



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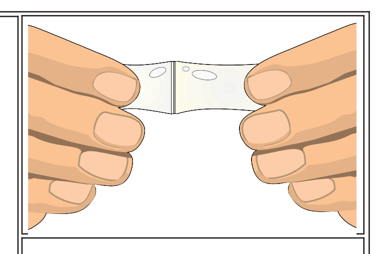
General Information and Common Procedures

Revision:

Date: 2/98

Number: **2.6**

Epoxy Mixing and Handling



Product Class: R, F, W, C

Skill Level: Intermediate

Level of Conformance: High

OUTLINE

This procedure covers epoxy mixing and handling. The epoxy covered by this procedure has multiple uses including solder resist repair, base board repair, circuitry over-coating and delamination repair.

NOTE

For high strength or high temperature applications two part epoxies will generally have the best properties.

REFERENCES

2.1 Handling Electronic Assemblies
2.2 Cleaning
2.5 Baking and Preheating

TOOLS AND MATERIALS

Balance/Scale
Cleaner
Color Agent, Various Colors
Epoxy
Foam Swab
Heat Lamp
Mixing Cup
Mixing Stick
Oven
Wipes

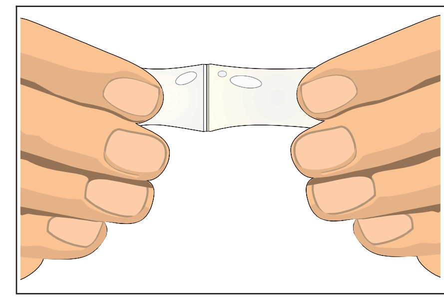


Figure 1 Mix resin and activator inside package of prepackaged epoxy.

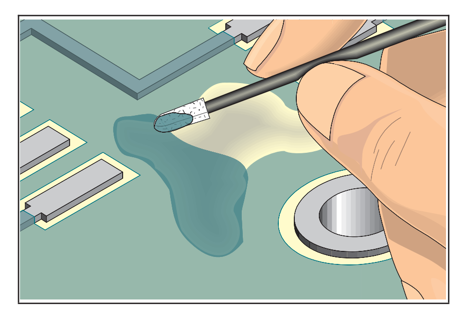


Figure 2 Apply epoxy. Foam swab may be used to add texture.

PRINTED WIRING BOARD PREPARATION

The area where the epoxy is to be applied should be prepared prior to mixing the epoxy. This preparation may include preheating the affected area to improve absorption of the applied epoxy. The entire printed wiring board may also be heated in an oven or with a heat lamp.

CAUTION

Some components may be sensitive to high temperatures.

CAUTION

Avoid skin contact with epoxy materials.

PROCEDURE - Prepackaged Two Part Epoxy

1. Remove the clip separating the resin and activator. Mix by squeezing both halves together with your fingers. Mix for at least one minute to ensure a complete mix of the resin and activator. (See Figure 1.)
2. Cut open one end of the epoxy tube and squeeze the contents into a mixing cup. Mix again with a mixing stick to ensure a thorough mixture of the resin and activator.

NOTE

For bubble free epoxy, remove the clip separating the resin and activator. Cut open one end of the Epoxy tube and squeeze the contents into a mixing cup. Slowly stir the mixture with the mixing stick. Be sure to stir the mixture for at least 2 minutes to ensure that all the resin and actuator have completely mixed.

3. If needed, add color agent to the mixed epoxy. Stir slowly to prevent bubbles.

CAUTION

Be sure the color agent is compatible with the epoxy mixture.

4. Apply or use as needed. (See Figure 2.)
5. Cure the epoxy per the manufacturer's recommendations.

EVALUATION

1. Visual examination of epoxy for texture and color match.
2. Testing of epoxy surface for complete cure.
3. Electrical tests as applicable.

NOTES



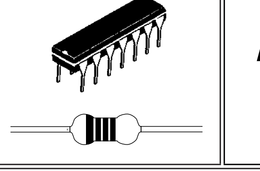
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Rework of
Electronic Assemblies

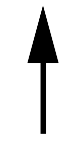
Revision: **A**
Date: 5/02

Number: **3.1.1**

Through-Hole Desoldering

Continuous Vacuum Method





Product Class: R, F, W
Skill Level: Intermediate
Level of Conformance: High

EQUIPMENT REQUIRED

Continuous vacuum desoldering system
Desoldering tip
Damp sponge

OPTIONAL EQUIPMENT

N/A

MATERIALS

Flux-cored solder
Flux
Cleaner
Tissue/wipes

PROCEDURE

1. Remove conformal coating (if any) and clean work area of any contamination, oxides, residues or fluxes.
2. Install thermal drive desoldering tip handpiece.
3. Start with tip temperature of approximately 315°C and change as necessary.
4. Apply flux to all solder connections (optional).
5. Thermal shock tip with damp sponge.
6. Tin tip with solder.
7. Lower tip contacting solder connection. (See Figure 1.)
8. Confirm complete solder melt of contacted lead. (See Figure 2.)

   NOTE

   Auxiliary heating may be required on solder joints with a large thermal mass. This is most common on multilayer PC boards.
9. For a flat lead, move lead back and forth; for a round lead, use a circular motion and apply vacuum while continuing lead movement. (See Figures 3 & 4.)
10. Lift tip from lead, hold vacuum for sufficient time to clear all molten solder from heater chamber. (See Figure 5.)
11. Repeat for all solder connections.
12. Re-tin tip end with solder and return handpiece to its stand.
13. Clean lands as required for component replacement.

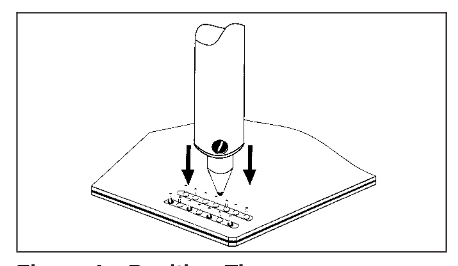


Figure 1 Position Tip

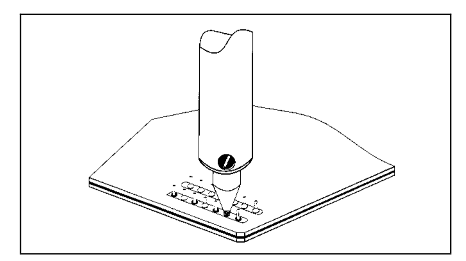


Figure 2 Melt Solder

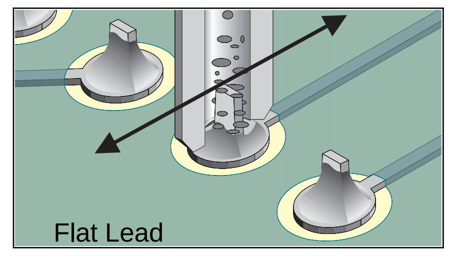


Figure 3 Move Lead & Apply Vacuum

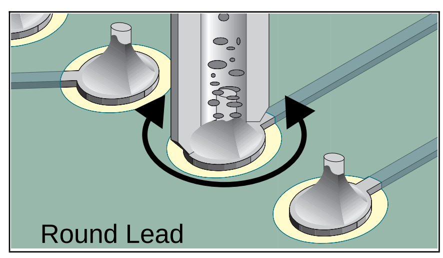


Figure 4 Move Lead & Apply Vacuum

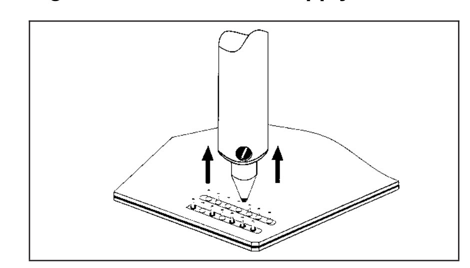


Figure 5 Lift Handpiece

NOTES



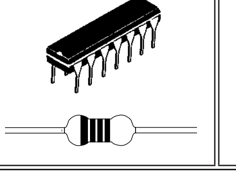
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Rework of
Electronic Assemblies

Revision:
Date: 5/02

Number: **3.1.2**

Through-Hole Desoldering

Continuous Vacuum Method – Partial Clinch



Product Class: R, F, W
Skill Level: Intermediate
Level of Conformance: High

EQUIPMENT REQUIRED

Continuous vacuum desoldering system
Desoldering tip
Damp sponge

OPTIONAL EQUIPMENT

N/A

MATERIALS

Flux-cored solder
Flux
Cleaner
Tissue/wipes

NOTE

On multileaded devices a skipping/alternating pattern may be needed to reduce heat buildup.

PROCEDURE

1. Remove conformal coating (if any) and clean work area of any contamination, oxides, residues or fluxes.
2. Install desoldering tip handpiece.
3. Start with tip temperature of approximately 315°C and change as necessary.
4. Apply flux to all solder connections (optional).
5. Thermal shock tip with damp sponge.
6. Tin tip with solder.
7. Lower tip contacting solder connection.
8. Confirm complete solder melt of contacted lead and gently straighten the lead to a vertical position. (See Figure 1.)
9. For a flat lead, move lead back and forth; for a round lead, use a circular motion and apply vacuum while continuing lead movement. (See Figures 2 & 3.)
10. Lift tip from lead, hold vacuum for sufficient time to clear all molten solder from heater chamber. (See Figure 4.)
11. Repeat for all solder connections.
12. Re-tin tip end with solder and return handpiece to its stand.
13. Clean lands as required for component replacement.

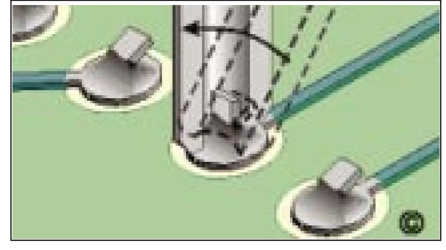


Figure 1

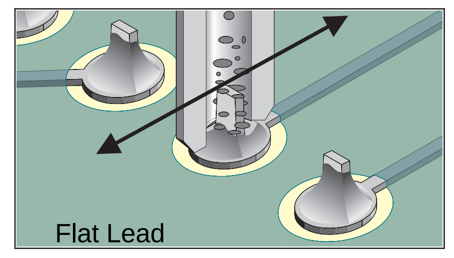


Figure 2

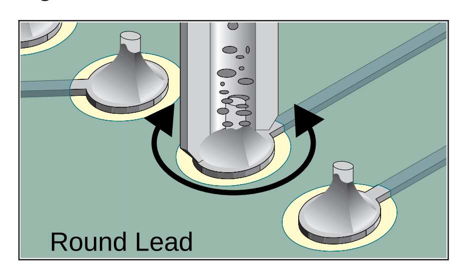


Figure 3

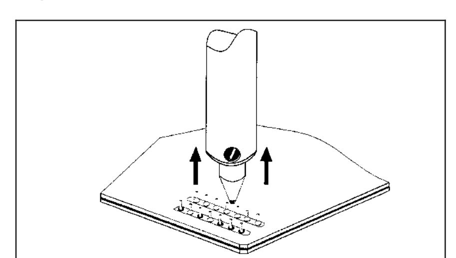


Figure 4

Number: **3.1.2**	Subject: **Through-Hole Desoldering**
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NOTES



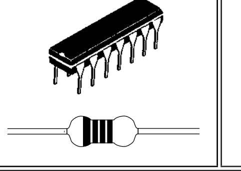
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Rework of
Electronic Assemblies

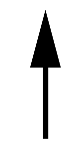
Revision:
Date: 5/02

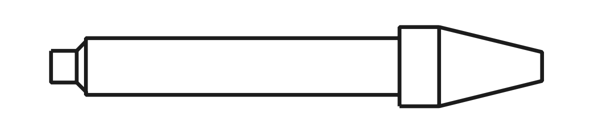
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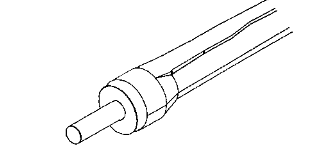
Through-Hole Desoldering

Continuous Vacuum Method – Full Clinch

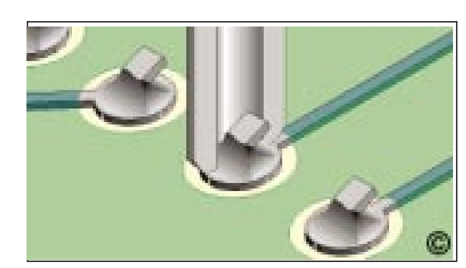








Product Class: R, F, W
Skill Level: Intermediate
Level of Conformance: High


Figure 1

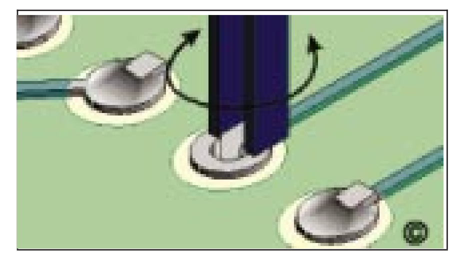

Figure 2


Figure 3

EQUIPMENT REQUIRED

Continuous vacuum desoldering system
Desoldering tip
Damp sponge
Non-metallic tool (wood stick or spudger)
Flat nose pliers

OPTIONAL EQUIPMENT

N/A

MATERIALS

Flux-cored solder
Flux
Cleaner
Tissue/wipes

NOTES

On multileaded devices a skipping/alternating pattern may be needed to reduce heat buildup.

PROCEDURE

1. Remove conformal coating (if any) and clean work area of any contamination, oxides, residues or fluxes.
2. Install desoldering tip handpiece.
3. Start with tip temperature of approximately 315°C and change as necessary.
4. Apply flux to all solder connections (optional).
5. Thermal shock tip with damp sponge.
6. Tin tip with solder.
7. Lower tip contacting solder connection.
8. Confirm complete solder melt of contacted lead and apply vacuum. (See Figure 1.)
9. Lift tip from lead, hold vacuum for sufficient time to clear all molten solder from heater chamber.
10. Inspect connection to ensure only a small amount of solder remains between lead and land area.

    NOTE: If excess solder exists use wicking braid and iron to remove solder. (See 3.1.5.)
11. Using a Flat Nose pliers gently rotate the lead laterally until the joint separates. (See Figure 2.)

12. Lift lead with wood stick to vertical position. (See Figure 3.)
13. Repeat for all solder connections.
14. Re-tin tip end with solder and return handpiece to its stand.
15. Clean lands as required for component replacement.

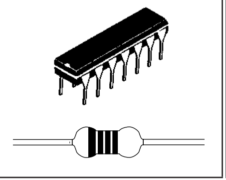


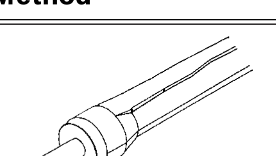
7711A
Rework of
Electronic Assemblies

Revision:
Date: 5/02
Number: **3.1.4**

Through-Hole Desoldering

Full Clinch Straightening Method





Product Class: R, F, W
Skill Level: Intermediate
Level of Conformance: High

EQUIPMENT REQUIRED

Soldering Iron
Continuous vacuum desoldering system
Desoldering tip
Chisel tip
Damp sponge
Non-metallic tool (wood stick or spudger)
Flat nose pliers

OPTIONAL EQUIPMENT

N/A

MATERIALS

Flux-cored solder
Flux
Cleaner
Tissue/wipes

NOTE: On multileaded devices a skipping/alternating pattern may be needed to reduce heat buildup.

PROCEDURE

1. Remove conformal coating (if any) and clean work area of any contamination, oxides, residues or fluxes.
2. Install soldering iron tip and desoldering tip into handpieces.
3. Start with tip temperature of approximately 315°C and change as necessary.
4. Apply flux to all solder connections (optional).
5. Thermal shock tip with damp sponge.
6. Lower soldering iron tip contacting solder connection. (See Figure 1.)
7. Confirm complete solder melt of contacted lead
8. Lift lead with a non-metallic tool to the vertical position. (See Figure 2.)
9. Lower desoldering tip contacting solder connection.
10. Confirm complete solder melt of contacted lead.
11. For a flat lead, move lead back and forth; for a round lead, use a circular motion and apply vacuum while continuing lead movement. (See Figures 3 & 4.)
12. Lift tip from lead, hold vacuum for sufficient time to clear all molten solder from heater chamber.
13. Repeat for all solder connections.
14. Re-tin tip end with solder and return handpiece to its stand.
15. Clean lands as required for component replacement.





Figure 1



Figure 2

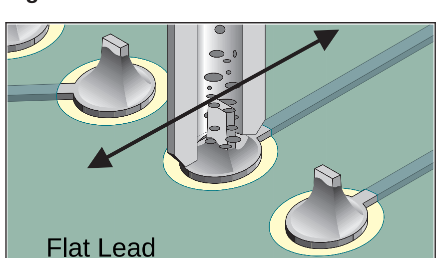


Figure 3

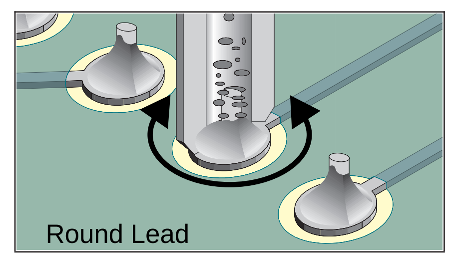


Figure 4

NOTES



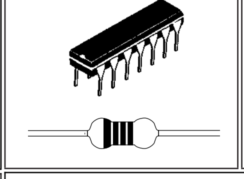
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Rework of
Electronic Assemblies

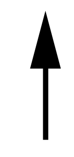
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Date: 5/02

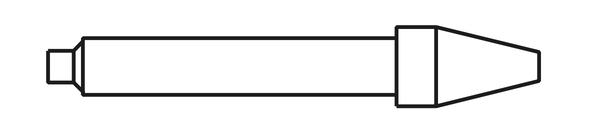
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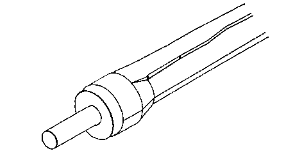
Through-Hole Desoldering

Full Clinch Wicking Method









Product Class: R, F, W
Skill Level: Advanced
Level of Conformance: High



Figure 1



Figure 2

EQUIPMENT REQUIRED

Soldering iron
Chisel tip
Damp sponge
Non-metallic tool (wood stick or spudger)
Wicking braid



OPTIONAL EQUIPMENT

N/A



MATERIALS

Flux-cored solder
Flux
Cleaner
Tissue/wipes



NOTE

On multileaded devices a skipping/alternating pattern may be needed to reduce heat buildup.

CAUTION

This procedure is not recommended for the removal of solder in plated-through holes due to the risk of conductor damage. This method should only be used when no other method exists. Wicking is most affective on surface solder only.

CAUTION

Trim the wicking braid to prevent damage to other land areas or components.

PROCEDURE

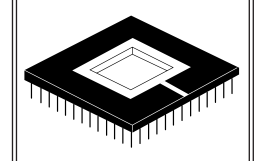
1. Remove conformal coating (if any) and clean work area of any contamination, oxides, residues or fluxes.
2. Install soldering iron tip in handpiece.
3. Start with tip temperature of approximately 315°C and change as necessary.
4. Apply flux to all solder connections (optional).
5. Thermal shock tip with damp sponge.
6. Apply braid material to lead land junction. (See Figure 1.)
7. Lower tip contacting braid material connection.
8. Observe solder wicking into the braid material.

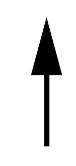
NOTE: Once solder stops wicking into the braid material remove the iron and braid material immediately.

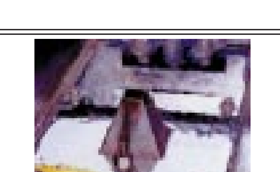
9. Remove tip and braid material.
10. Confirm complete solder removal from area.
11. Lift lead with a non-metallic tool to the vertical position. (See Figure 2.)
12. Repeat for all solder connections.
13. Re-tin tip end with solder and return handpiece to its stand.
14. Clean lands as required for component replacement.

PGA and Connector Removal

Solder Fountain Method







Product Class: R, F, W, C
Skill Level: Expert
Level of Conformance: Medium



EQUIPMENT REQUIRED

Solder fountain
Chimney or nozzle to match part
Removal tool
Pallet to hold board over fountain
Preheat oven

OPTIONAL EQUIPMENT

Vacuum pick-up tool

MATERIALS

Flux-cored solder
Cleaner
Heat resistant, antistatic gloves
Protective face gear
Heat resistant tape

PROCEDURE

This process is for experienced operators only. Caution must be exercised due to working with hot, molten solder.

1. Set solder fountain pot control to the required temperature for removing that particular component from that particular board. Wait until solder pot reaches the set temperature.
2. Attach the correct nozzle or chimney to the solder pot. (See Figure 1.)
3. Set the timer for the amount of time the fountain is to be running for that particular part.
4. The area around the rework site may be masked with a high temperature resistant tape, or similar material, to protect the adjacent area during rework. (See Figure 2.)
5. Preheat the board to the desired temperature, depending on the component restrictions and the board T_g material.
6. Flux the bottom side site where the part will be removed. (See Figure 2.)
7. Place the board on the pallet over the solder fountain and trip the timer. (See Figure 3.)
8. At the end of the timer cycle, use vacuum pickup tool, tweezers, or removal tool to remove the part from the board.
9. Clean the flux residue, if required, and inspect.

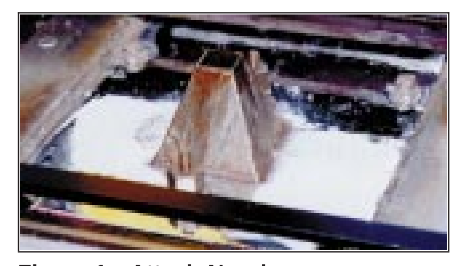


Figure 1 Attach Nozzle

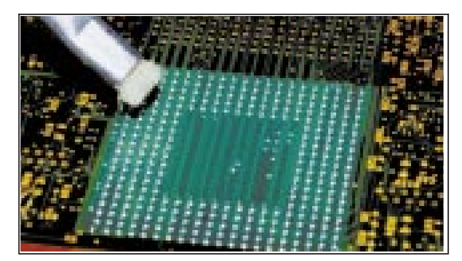


Figure 2 Flux

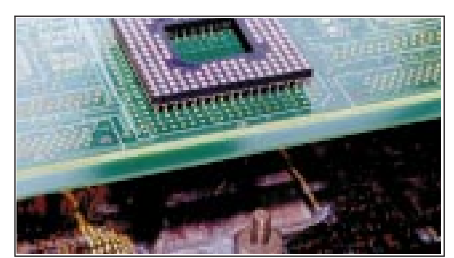


Figure 3 Place Over Solder Fountain

NOTES

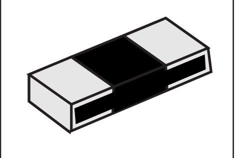


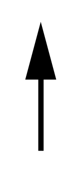
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Date: 2/98

Number: **3.3.1**

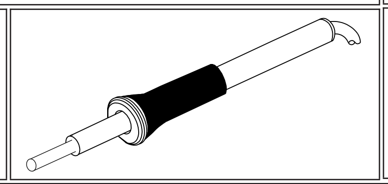
Chip Component Removal

Bifurcated Tip









Product Class: R, F, W, C
Skill Level: Intermediate
Level of Conformance: High

EQUIPMENT REQUIRED

Soldering system
Chip removal tip
Soldering handpiece

OPTIONAL EQUIPMENT

Tweezers
Controllable preheater

MATERIALS

Flux-cored solder
Flux
Cleaner

PROCEDURE

1. Remove conformal coating (if any) and clean work area of any contamination, oxides or residues.
2. Install the chip removal tip into the soldering handpiece.
3. Start with tip temperature of approximately 315°C and change as necessary.
4. Apply flux to all lead/land areas. (See Figure 1.)
5. Remove old solder from tip and thermal shock with a damp sponge.
6. Apply solder to inside of tip forming a crown. (See Figure 2.)
7. Lower tip over component until tip contacts solder joints. (See Figure 3.)
8. Confirm solder melt and lift component from PWB. (See Figures 4 & 5.) (Surface tension of the tip should lift the component from the board. If this does not occur, use of tweezers to lift the component is optional.)

   NOTE: Chip components may have adhesive between the body and the board. If adhesive is used, it may be necessary to slightly turn the component to allow the component to be removed from the board. This must only be accomplished after complete solder melt to prevent damage.
9. Release component from tip by wiping on a heat resistant surface.
10. Re-tin tip with solder.
11. Prepare lands for component replacement.

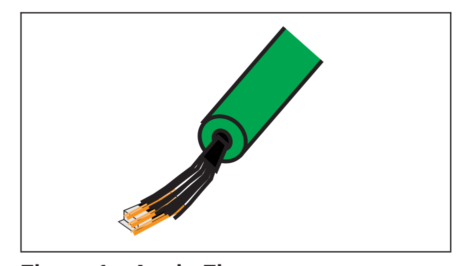


Figure 1 Apply Flux

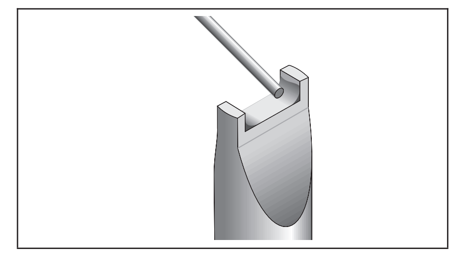


Figure 2 Tin Tips



Figure 3 Position Tip

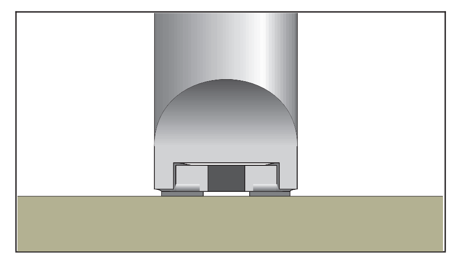


Figure 4 Melt All Joints

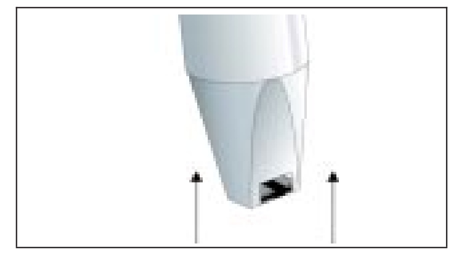


Figure 5 Lift Component

NOTES



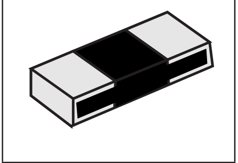
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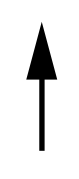
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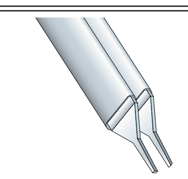
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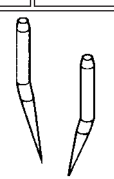
Chip Component Removal

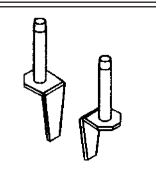
Tweezer Method

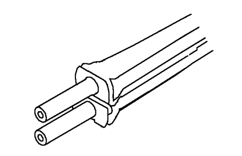












Product Class: R, F, W, C
Skill Level: Intermediate
Level of Conformance: High

EQUIPMENT REQUIRED

Soldering system
Chip removal tips
Tweezer handpiece

MATERIALS

Flux
Cleaner

PROCEDURE

1. Remove conformal coating (if any) and clean work area of any contamination, oxides or residues.
2. Install chip removal tips into tweezer handpiece.
3. Start with tip temperature of approximately 315°C and change as necessary.
4. Apply flux to the component terminations. (See Figure 1.)
5. Clean any residue from tips.
6. Lower tips over component and squeeze handpiece to contact both solder joints. (See Figure 2.)
7. Confirm complete solder melt of both joints and lift component from PWB. (See Figures 3 & 4.)

   NOTE: Chip components may have adhesive between the body and the board. If adhesive is used, it may be necessary to slightly turn the component to allow the component to be removed from the board. This must only be accomplished after complete solder melt to prevent damage.
8. Release component onto a heat resistant surface.
9. Prepare lands for component replacement.

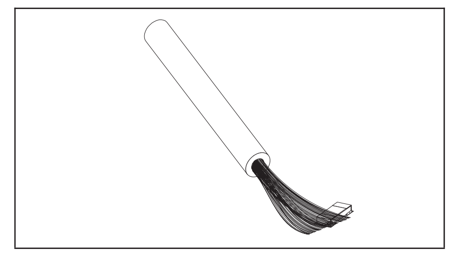


Figure 1 Flux Component

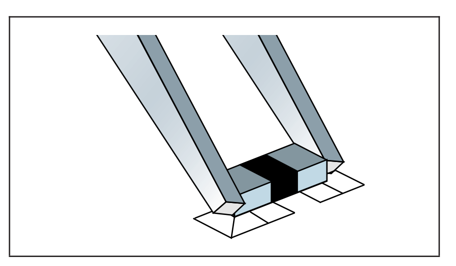


Figure 2 Position Tip

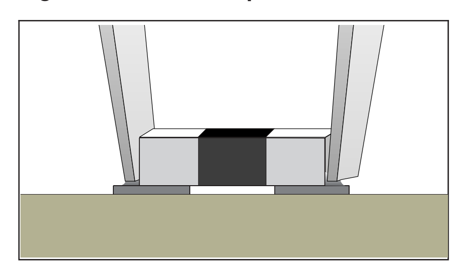


Figure 3 Melt Joints

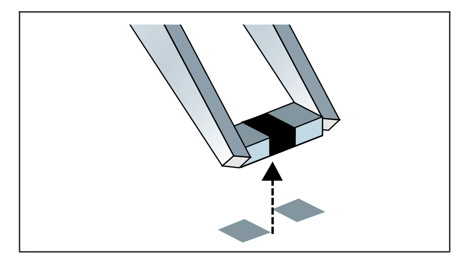


Figure 4 Lift Component

NOTES



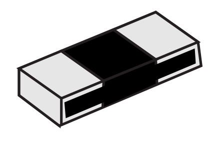
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Date: 2/98

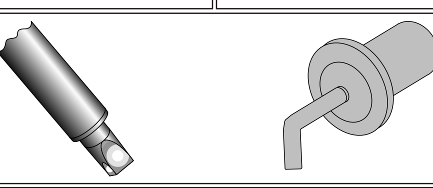
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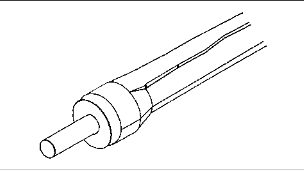
Chip Removal (bottom termination)

Hot Air Method









Product Class: R, F, W, C
Skill Level: Intermediate
Level of Conformance: High

EQUIPMENT REQUIRED

Soldering system
Hot air pencil
Hot air tip
Tweezers

MATERIALS

Flux
Cleaner
Tissue/wipe

PROCEDURE

1. Remove conformal coating (if any) and clean work area of any contamination, oxides or residues.
2. Install tip into hot air pencil.
3. Set heater temperature to approximately 425°C and change as necessary.
4. Apply flux to component terminations. (See Figure 1.)
5. Adjust pressure output so hot air scorches a tissue from approximately 0.5 cm. (See Figure 2.)
6. Direct hot air over component with tip at a distance of 0.5 cm until complete solder melt is observed. (See Figure 3.)
7. Lift component from PWB. (See Figure 4.)

   NOTE: Chip components may have adhesive between the body and the board. If adhesive is used, it may be necessary to slightly turn the component to allow the component to be removed from the board. This must only be accomplished after complete solder melt to prevent damage.
8. Release component onto a heat resistant surface.
9. Prepare lands for component replacement.

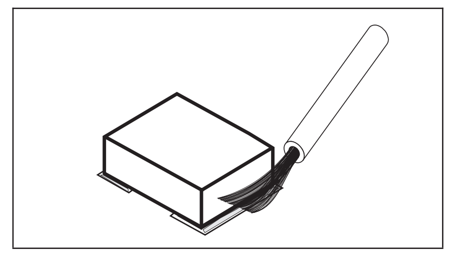


Figure 1 Flux Component

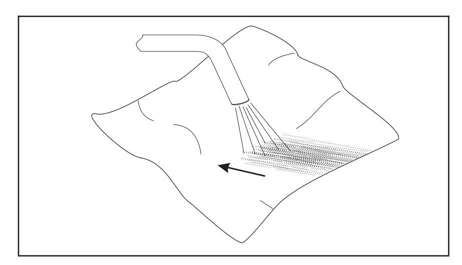


Figure 2 Adjust Pressure

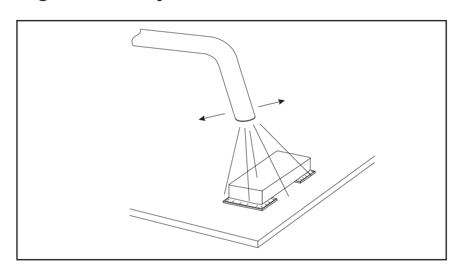


Figure 3 Melt Joints

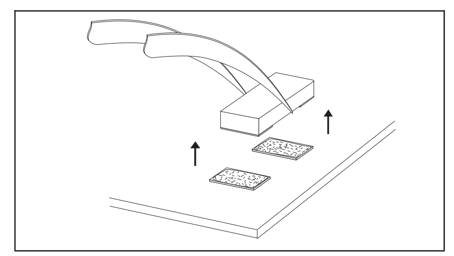


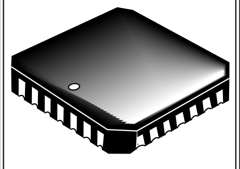
Figure 4 Lift Component

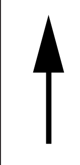
Number: **3.3.3**	Subject: **Chip Removal (bottom termination)**
Revision: Date: 2/98	

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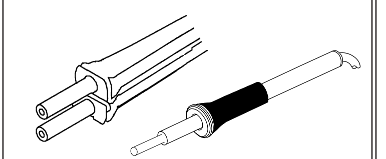
Leadless Component Removal

Solder Wrap Method









Product Class: R, F, W, C
Skill Level: Advanced
Level of Conformance: High

EQUIPMENT REQUIRED

Soldering system
Tweezer handpiece
Soldering handpiece
Removal tips
Chisel tip



MATERIALS

Flux-cored solder
Cleaner

PROCEDURE

1. Remove conformal coating (if any) and clean work area of any contamination, oxides or residues.
2. Install removal tips into tweezer.
3. Start with tip temperature of approximately 315°C and change as necessary.
4. Tack solder to one of the end solder joints using soldering handpiece with chisel tip installed. (See Figure 1.)
5. Wrap solder around the four sides of component.
6. Terminate solder at end of last side using soldering handpiece.
7. Remove old solder from tips and thermal shock tips with damp sponge.
8. Tin inside edges of tips with solder. (See Figure 2.)
9. Lower tips over component and squeeze handpiece. (See Figure 3.)
10. Contact ALL solder joints with tips, confirm solder melt of ALL joints, and lift component from PWB. (See Figures 4 & 5.)
11. Release component onto a heat resistant surface.
12. Prepare lands for component replacement.

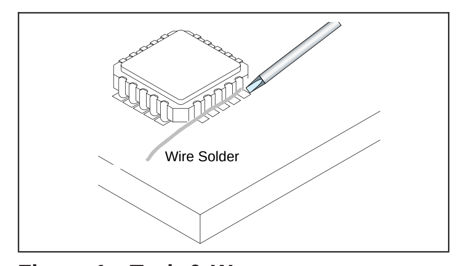


Figure 1 Tack & Wrap

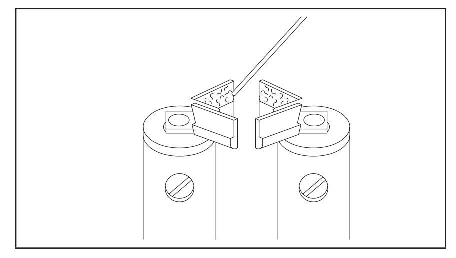


Figure 2 Tin Tips

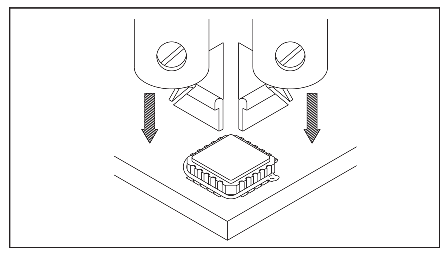


Figure 3 Position Tip

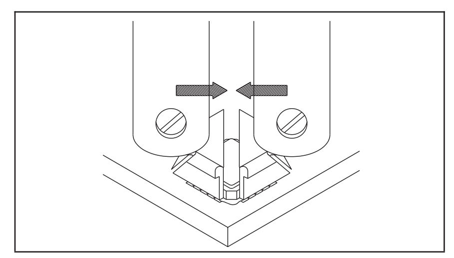


Figure 4 Melt All Joints

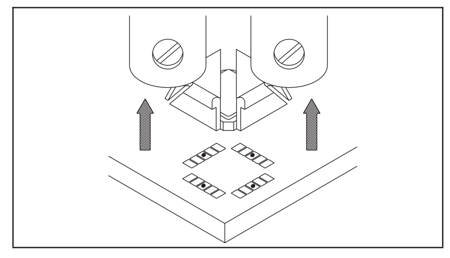


Figure 5 Lift Component

NOTES



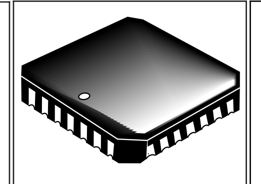
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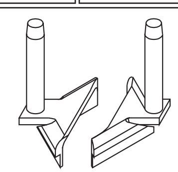
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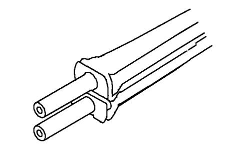
Number: **3.4.2**

Leadless Component Removal

Flux Application Method







Product Class: R, F, W, C
Skill Level: Advanced
Level of Conformance: High

EQUIPMENT REQUIRED

Soldering system
Tweezer handpiece
Removal tips

MATERIALS

Flux-cored solder
Flux
Cleaner

PROCEDURE

1. Remove conformal coating (if any) and clean work area of any contamination, oxides or residues.
2. Install removal tips into tweezer handpiece.
3. Start with tip temperature of approximately 315°C and change as necessary.
4. Apply flux to all solder joints. (See Figure 1.)
5. Remove old solder from tips and thermal shock tips with damp sponge.
6. Tin inside edges of tips with solder. (See Figure 2.)
7. Lower tips over component and squeeze handpiece. (See Figure 3.)
8. Contact ALL solder joints with tips, confirm solder melt of ALL joints and lift component from PWB. (See Figures 4 & 5.)
9. Release component onto a heat resistant surface.
10. Re-tin tips with solder.
11. Prepare lands for component replacement.

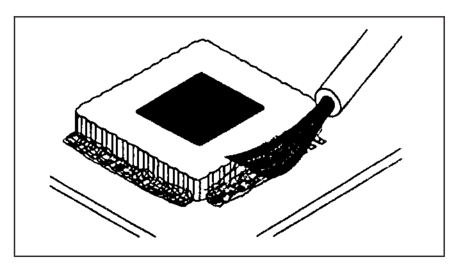


Figure 1 Apply Flux

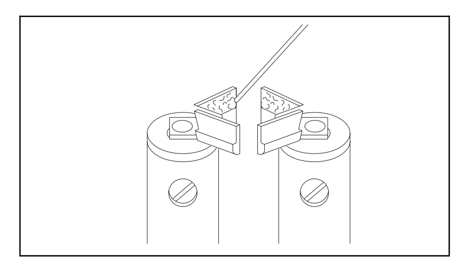


Figure 2 Tin Tips

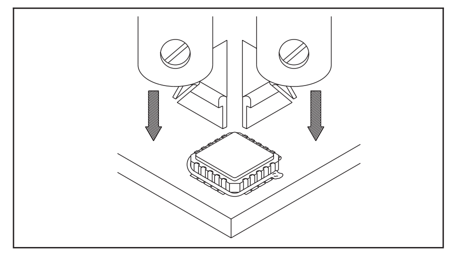


Figure 3 Position Tips

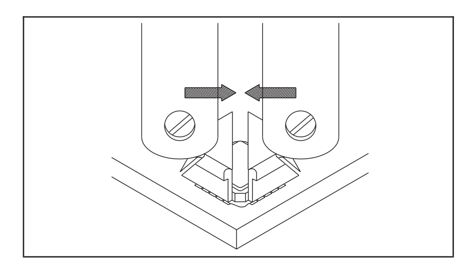


Figure 4 Melt All Joints

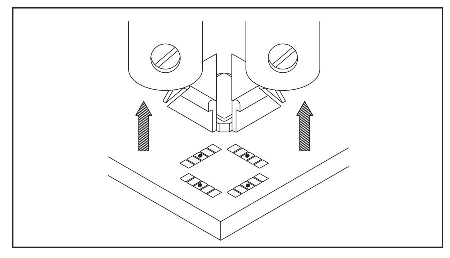


Figure 5 Lift Component

Number: **3.4.2**	Subject: **Leadless Component Removal**
Revision: Date: 2/98	

NOTES



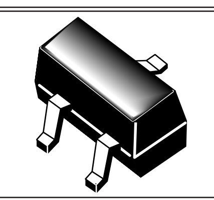
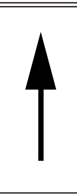
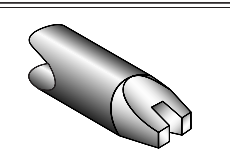
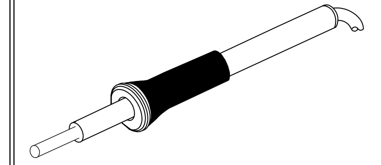
7711A
Rework of
Electronic Assemblies

Revision: A
Date: 10/03

Number: 3.5.1

SOT Removal

Flux Application Method

Product Class: R, F, W, C
Skill Level: Intermediate
Level of Conformance: High

EQUIPMENT REQUIRED

Soldering system
Removal tip
Soldering handpiece

OPTIONAL EQUIPMENT

Tweezers

MATERIALS

Flux-cored solder
Flux
Cleaner

PROCEDURE

1. Remove conformal coating (if any) and clean work area of any contamination, oxides or residues.
2. Install removal tip into soldering handpiece.
3. Start with tip temperature of approximately 315°C and change as necessary.
4. Apply flux to all lead/land areas. (See Figure 1.)
5. Remove old solder from tip and thermal shock tip with damp sponge.
6. Tin bottom edges of tip with solder. (See Figure 2.)
7. Lower tip over component contacting ALL leads with tip. (See Figures 3 & 4.)
8. Confirm solder melt of ALL joints and lift component from PWB. (See Figures 4 & 5.) (Surface tension of the tip should lift the component from the board. If this does not occur, use of tweezers to lift the component is optional.)
9. Release component from tip by wiping on a heat resistant surface.
10. Re-tin tip with solder.
11. Prepare lands for component replacement.

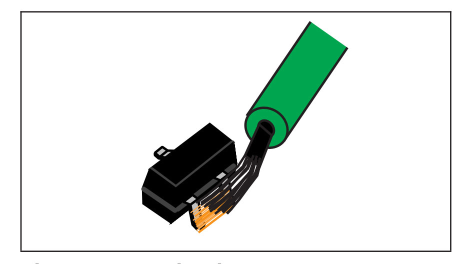


Figure 1 Apply Flux

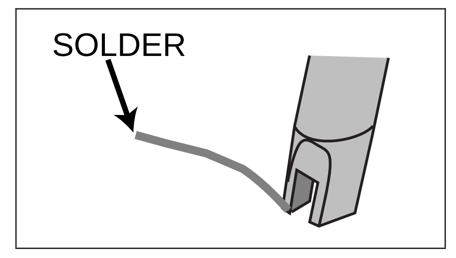


Figure 2 Tin Tip

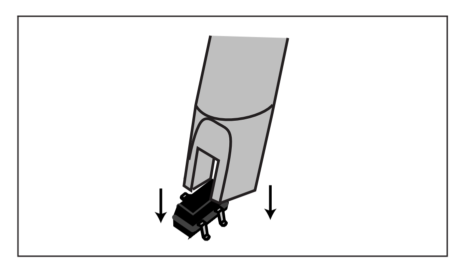


Figure 3 Position Tip

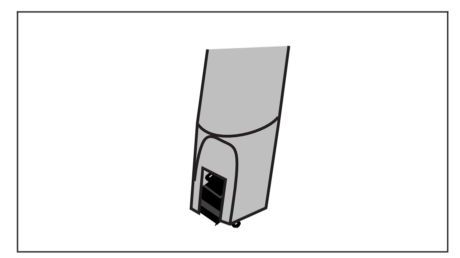


Figure 4 Melt All Joints

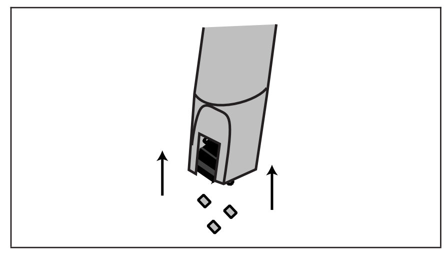


Figure 5 Lift Component

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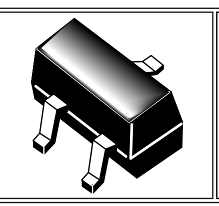
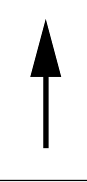
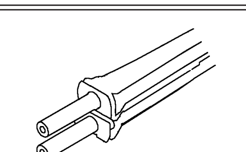
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Electronic Assemblies

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Date: 10/03

Number: 3.5.2

SOT Removal

Flux Application Method – Tweezer

Product Class: R, F, W, C
Skill Level: Intermediate
Level of Conformance: High

EQUIPMENT REQUIRED

Soldering system
Removal tips
Tweezer handpiece

MATERIALS

Flux
Flux-cored solder
Cleaner

PROCEDURE

1. Remove conformal coating (if any) and clean work area of any contamination, oxides or residues.
2. Install removal tip into tweezer handpiece.
3. Start with tip temperature of approximately 315°C and change as necessary.
4. Apply flux to all lead/land areas. (See Figure 1.)
5. Clean residue from tips with damp sponge. (See Figure 2.)
6. Tin tips.
7. Lower tips over component and squeeze handpiece contacting ALL leads with tips. (See Figures 3 & 4.)
8. Confirm solder melt of ALL joints and lift component from PWB. (See Figures 4 & 5.)
9. Release component from tips by wiping on a heat resistant surface.
10. Prepare lands for component replacement.

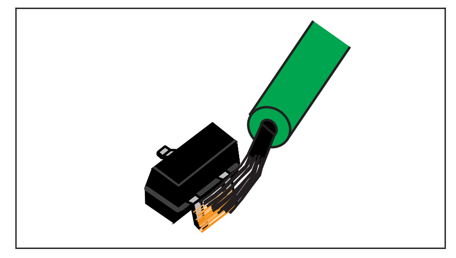


Figure 1 Apply Flux

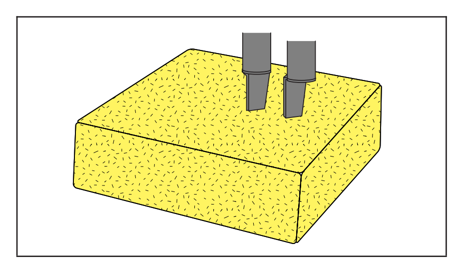


Figure 2 Clean Tips

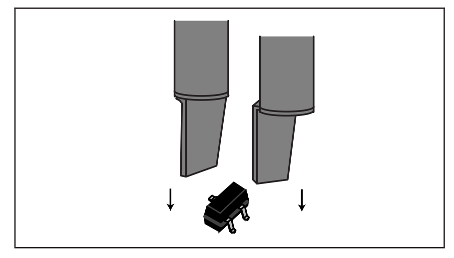


Figure 3 Position Tips

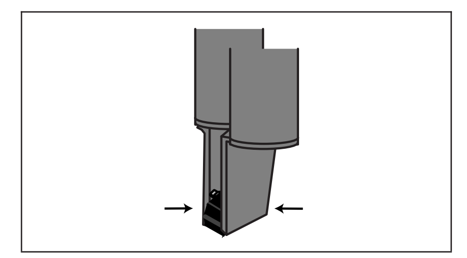


Figure 4 Melt All Joints

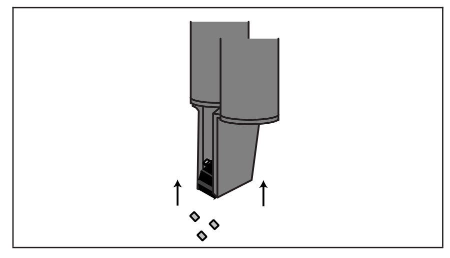


Figure 5 Lift Component

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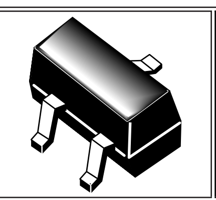
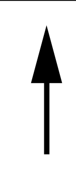
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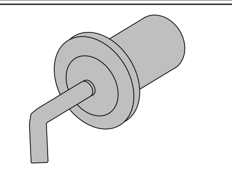
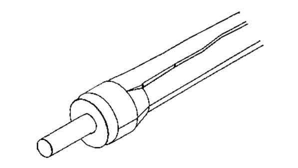
Revision: **A**
Date: 10/03

Number: **3.5.3**

SOT Removal

Hot Air Pencil

Product Class: R, F, W, C
Skill Level: Intermediate
Level of Conformance: High

EQUIPMENT REQUIRED

Soldering system
Hot air pencil
Hot air tip
Tweezers

MATERIALS

Flux-cored solder
Cleaner
Tissue/wipe

PROCEDURE

1. Remove conformal coating (if any) and clean work area of any contamination, oxides or residues.
2. Adjust pressure output so hot air scorches a tissue from approximately 0.5 cm away. (See Figure 1.)
3. Set heater temperature to approximately 425°C and change as necessary.
4. Install tip into the hot air pencil.
5. Apply flux to all lead/land areas. (See Figure 2.)
6. Position tip approximately 0.5 cm away from component. (See Figure 3.)
7. Direct hot air over component and heat until COMPLETE solder melt is observed on ALL solder joints. (See Figure 3.)
8. Grasp component with tweezers and lift away from PWB. (See Figure 4.)
9. Release component from tweezers on a heat resistant surface.
10. Prepare lands for component replacement.

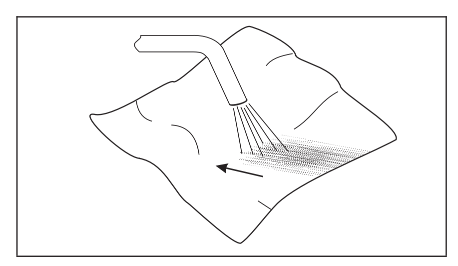


Figure 1 Adjust Air Pressure

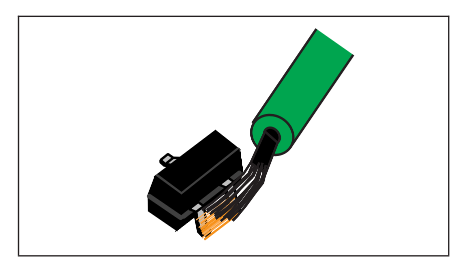


Figure 2 Apply Flux

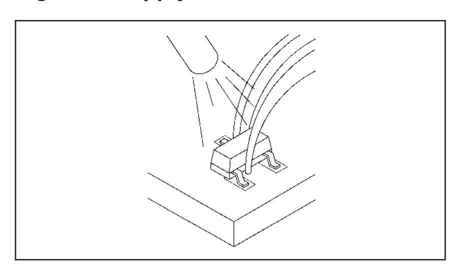


Figure 3 Melt All Joints

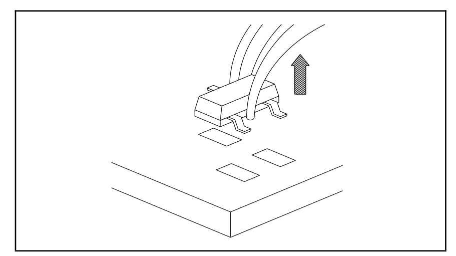


Figure 4 Lift Component

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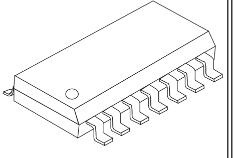
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Electronic Assemblies

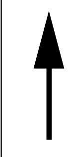
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Date: 2/98

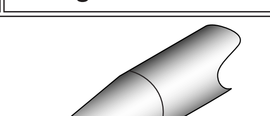
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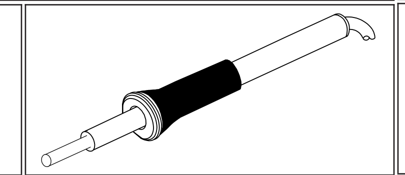
Gull Wing Removal (two-sided)

Bridge Fill Method









Product Class: R, F, W, C
Skill Level: Intermediate
Level of Conformance: High

EQUIPMENT REQUIRED

Soldering handpiece
Soldering system
Removal tip
Broad surfaced tip

OPTIONAL EQUIPMENT

Tweezers

MATERIALS

Flux-cored solder
Cleaner

PROCEDURE

1. Remove conformal coating (if any) and clean work area of any contamination, oxides or residues.
2. Install broad surface tip into soldering handpiece.
3. Start with tip temperature of approximately 315°C and change as necessary.
4. Using soldering handpiece, melt solder to form a solder bridge fill joining all component leads. (See Figure 1.)
5. Replace broad surfaced tip in soldering handpiece with removal tip.
6. Remove old solder from tip and thermal shock tip with damp sponge.
7. Tin bottom and inside edges of tip with solder. (See Figure 2.)
8. Lower tip over component contacting ALL leads with tip. (See Figures 3 & 4.)
9. Confirm solder melt of ALL joints and lift component from PWB. (See Figures 4 & 5.) (Surface tension of the tip should lift the component from the board. If this does not occur, use of tweezers to lift the component is optional.)
10. Release component from tip by wiping on a heat resistant surface.
11. Re-tin tip with solder.
12. Prepare lands for component replacement.

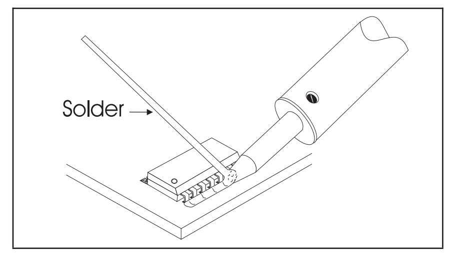


Figure 1 Bridge Fill

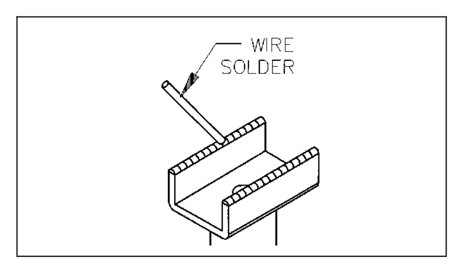


Figure 2 Tin Tip

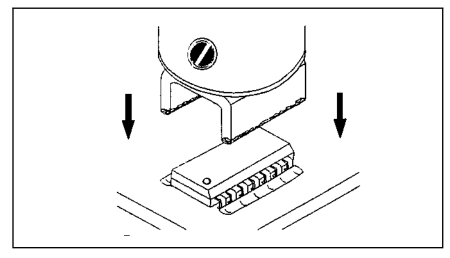


Figure 3 Position Tip

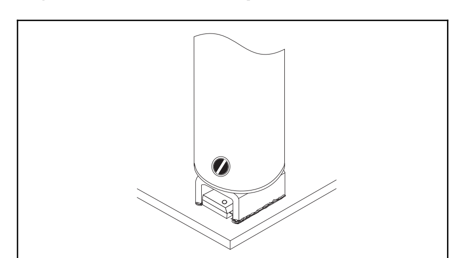


Figure 4 Melt All Joints

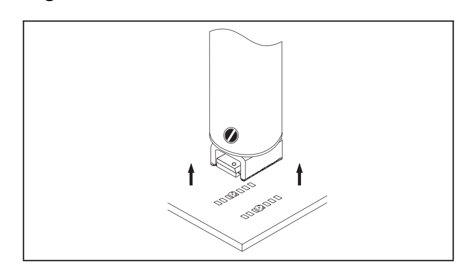
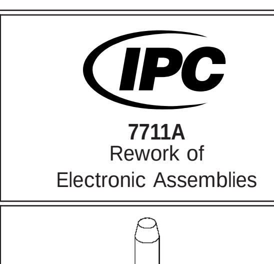


Figure 5 Lift Components

NOTES



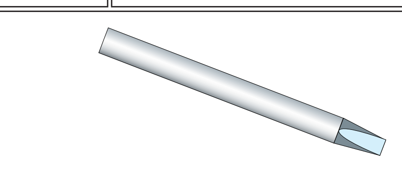
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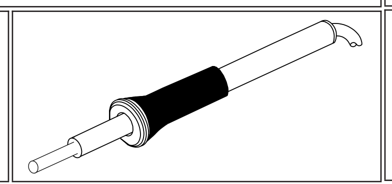
Revision: **A**
Date: 10/03

Number: **3.6.2**

Gull Wing Removal (two-sided)

Solder Wrap Method





Product Class: R, F, W, C
Skill Level: Intermediate
Level of Conformance: High

EQUIPMENT REQUIRED

Soldering system
Removal tip
Chisel tip
Soldering handpiece

OPTIONAL EQUIPMENT

Tweezers

MATERIALS

Flux-cored solder
Cleaner

PROCEDURE

1. Remove conformal coating (if any) and clean work area of any contamination, oxides or residues.
2. Install chisel tip into soldering handpiece.
3. Start with tip temperature of approximately 315°C and change as necessary.
4. Tack solder to one of the corner component leads using the soldering handpiece with a chisel tip installed. Wrap solder around the four sides of the component. Tack solder at the end of the last side. (See Figure 1.)
5. Replace chisel tip in soldering handpiece with removal tip.
6. Remove older solder from tip and thermal shock tip with damp sponge.
7. Tin bottom and inside edges of tip with solder. (See Figure 2.)
8. Lower tip over component contacting ALL leads with tip. (See Figures 3 & 4.)
9. Confirm solder melt of ALL joints and lift component from PWB. (See Figures 4 & 5.) (Surface tension of the tip should lift the component from the board. If this does not occur, use of tweezers to lift the component is optional.)
10. Release component from tip by wiping on a heat resistant surface.
11. Re-tin tip with solder.
12. Prepare lands for component replacement.

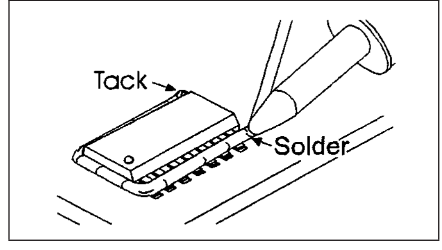


Figure 1 Tack and Wrap Solder

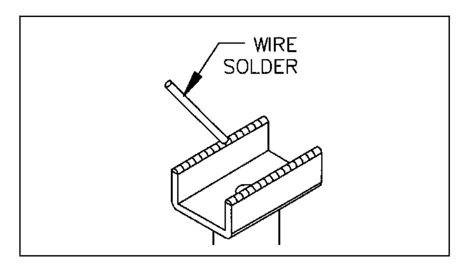


Figure 2 Tin Tip

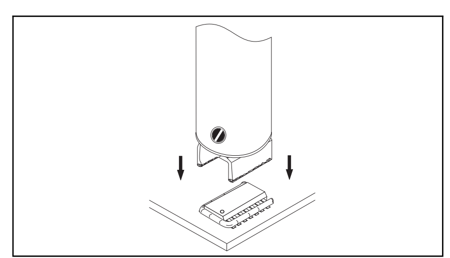


Figure 3 Position Tip

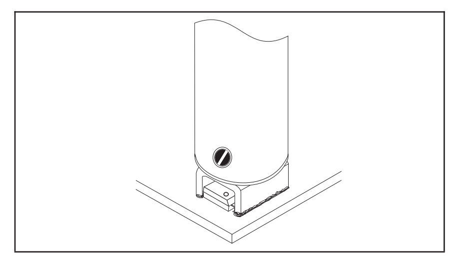


Figure 4 Melt All Joints

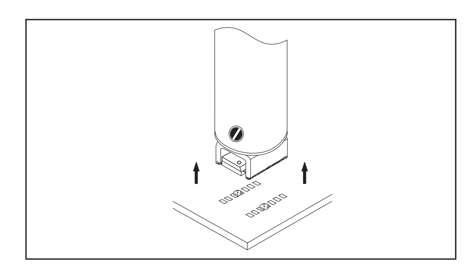
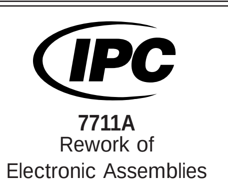


Figure 5 Lift Component

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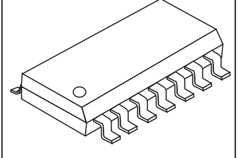
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Electronic Assemblies

Revision:
Date: 2/98

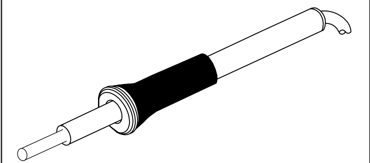
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Gull Wing Removal (two-sided)

Flux Application Method







Product Class: R, F, W, C
Skill Level: Intermediate
Level of Conformance: High

EQUIPMENT REQUIRED

Soldering system
Removal tip
Soldering handpiece

OPTIONAL EQUIPMENT

Tweezers

MATERIALS

Flux-cored solder
Flux
Cleaner

PROCEDURE

1. Remove conformal coating (if any) and clean work area of any contamination, oxides or residues.
2. Install removal tip into soldering handpiece.
3. Start with tip temperature of approximately 315°C and change as necessary.
4. Apply flux to all lead/land areas. (See Figure 1.)
5. Remove old solder from tip and thermal shock tip with damp sponge.
6. Tin bottom and inside edges of tip with solder. (See Figure 2.)
7. Lower tip over component contacting ALL leads with tip. (See Figures 3 & 4.)
8. Confirm solder melt of ALL joints and lift component from PWB. (See Figures 4 & 5.) (Surface tension of the tip should lift the component from the board. If this does not occur, use of tweezers to lift the component is optional.)
9. Release component from tip by wiping on a heat resistant surface.
10. Re-tin tip with solder.
11. Prepare lands for component replacement.

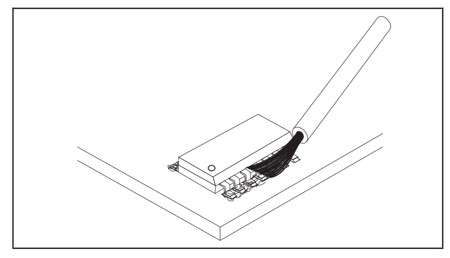


Figure 1 Apply Flux

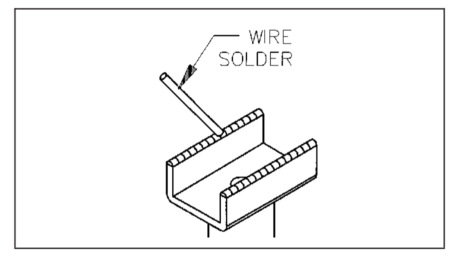


Figure 2 Tin Tip

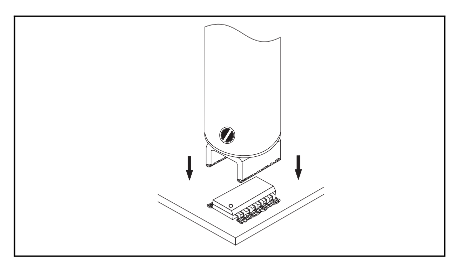


Figure 3 Position Tip

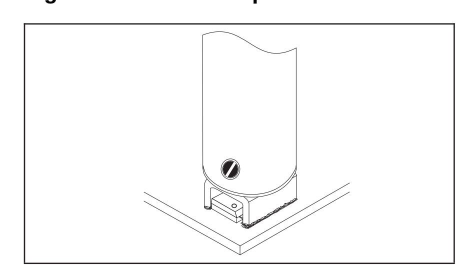


Figure 4 Melt All Joints

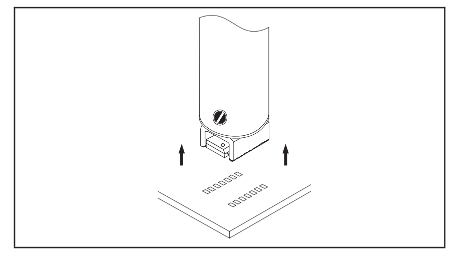


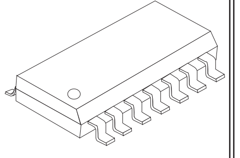
Figure 5 Lift Components

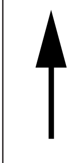
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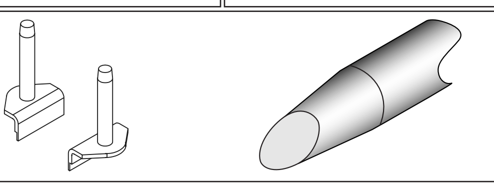


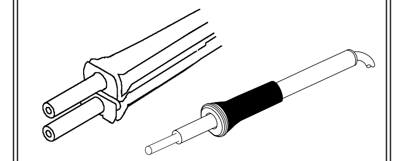
Gull Wing Removal (two-sided)

Bridge Fill Method – Tweezer









Product Class: R, F, W, C
Skill Level: Advanced
Level of Conformance: High

EQUIPMENT REQUIRED

Soldering system
Tweezer handpiece
Broad surfaced tip
Soldering handpiece

MATERIALS

Flux-cored solder
Cleaner

PROCEDURE

1. Remove conformal coating (if any) and clean work area of any contamination, oxides or residues.
2. Install broad surfaced tip into soldering handpiece.
3. Start with tip temperature of approximately 315°C and change as necessary.
4. Using soldering handpiece, melt solder to form a solder bridge fill joining all component leads. (See Figure 1.)
5. Install removal tips into tweezer handpiece.
6. Start with tip temperature of approximately 315°C and change as necessary.
7. Remove old solder from tips and thermal shock tips with damp sponge.
8. Tin bottom and inside edges of tips with solder. (See Figure 2.)
9. Lower tips over component and squeeze handpiece contacting ALL leads with tips. (See Figure 3.)
10. Confirm solder melt of ALL joints and lift component from PWB. (See Figure 4.)
11. Release component from tips by wiping on a heat resistant surface.
12. Re-tin tips with solder.
13. Prepare lands for component replacement.

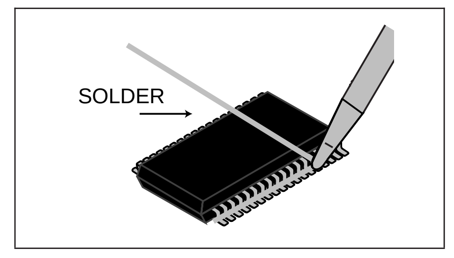


Figure 1 Bridge Fill

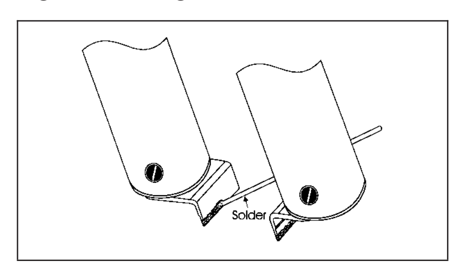


Figure 2 Tin Tips

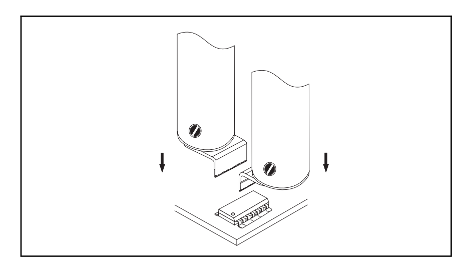


Figure 3 Position Tips

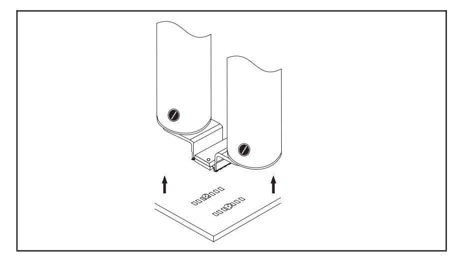


Figure 4 Lift Component

NOTES



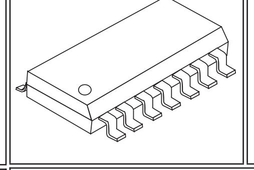
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Rework of
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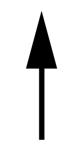
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Date: 10/03

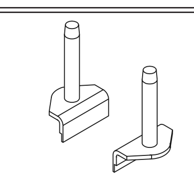
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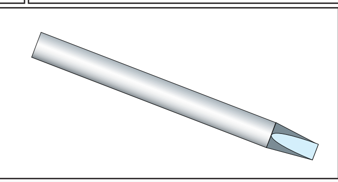
Gull Wing Removal (two-sided)

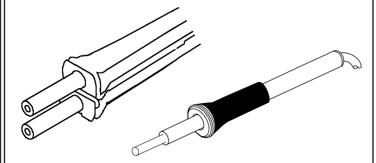
Solder Wrap Method – Tweezer











Product Class: R, F, W, C
Skill Level: Advanced
Level of Conformance: High

EQUIPMENT REQUIRED

Soldering system
Tweezer handpiece
Removal tips
Chisel tip
Soldering handpiece

MATERIALS

Flux-cored solder
Cleaner

PROCEDURE

1. Remove conformal coating (if any) and clean work area of any contamination, oxides or residues.
2. Install chisel tip into soldering handpiece.
3. Start with tip temperature of approximately 315°C and change as necessary.
4. Tack solder to one of the corner component leads using the soldering handpiece with a chisel tip installed. Wrap solder around the four sides of the component. Tack solder at the end of the last side. (See Figure 1.)
5. Install removal tips into tweezer handpiece.
6. Start with tip temperature of approximately 315°C and change as necessary.
7. Remove old solder from tips and thermal shock tips with damp sponge.
8. Tin bottom and inside edges of tips with solder. (See Figure 2.)
9. Lower tips over component and squeeze handpiece contacting ALL leads with tips. (See Figure 3.)
10. Confirm solder melt of ALL joints and lift component from PWB. (See Figure 4.)
11. Release component from tips by wiping on a heat resistant surface.
12. Re-tin tips with solder.
13. Prepare lands for component replacement.



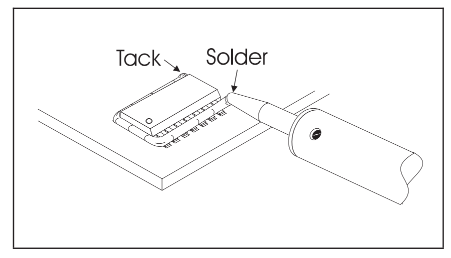


Figure 1 Tack Solder

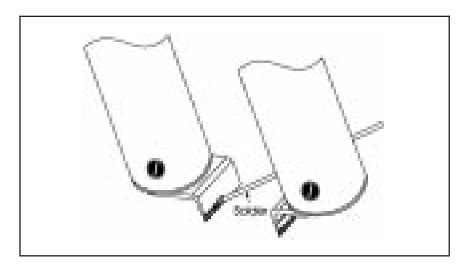


Figure 2 Tin Tips

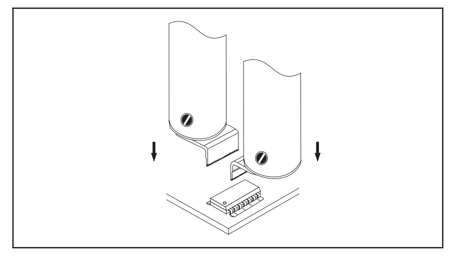


Figure 3 Position Tips

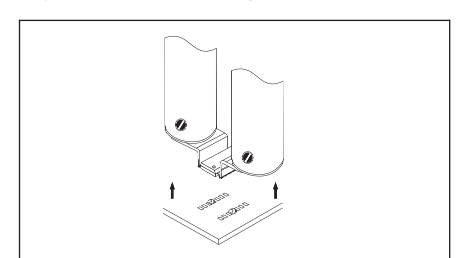


Figure 4 Lift Component

Number: **3.6.5**	Subject: **Gull Wing Removal (two-sided)**
Revision: **A** Date: 10/03	

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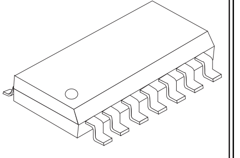
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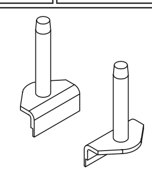
Revision: A
Date: 10/03

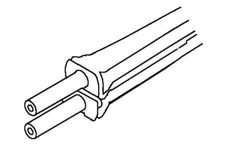
Number: 3.6.6

Gull Wing Removal (two-sided)

Flux Application Method – Tweezer







Product Class: R, F, W, C
Skill Level: Advanced
Level of Conformance: High

EQUIPMENT REQUIRED

Soldering system
Tweezer handpiece
Removal tips

MATERIALS

Flux-cored solder
Flux
Cleaner

PROCEDURE

1. Remove conformal coating (if any) and clean work area of any contamination, oxides or residues.
2. Install removal tips into tweezer handpiece.
3. Start with tip temperature of approximately 315°C and change as necessary.
4. Apply flux to all lead/land areas. (See Figure 1.)
5. Remove old solder from tips and thermal shock tips with damp sponge.
6. Tin bottom and inside edges of tips with solder. (See Figure 2.)
7. Lower tips over component and squeeze handpiece contacting ALL leads with tips. (See Figure 3.)
8. Confirm solder melt of ALL joints and lift component from PWB. (See Figure 4.)
9. Release component from tips by wiping on a heat resistant surface.
10. Re-tin tips with solder.
11. Prepare lands for component replacement.

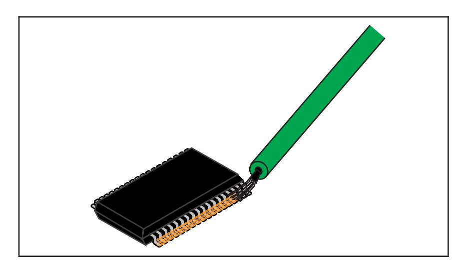


Figure 1 Apply Flux

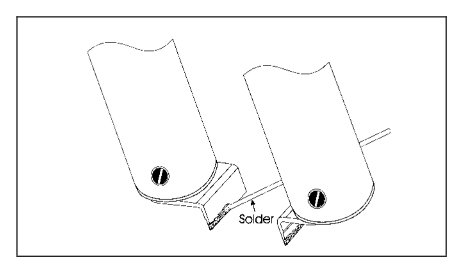


Figure 2 Tin Tips

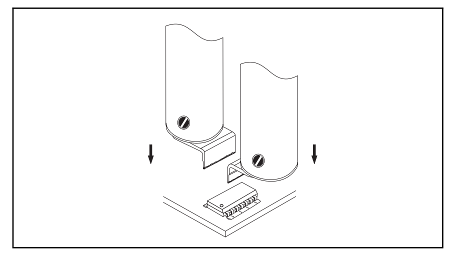


Figure 3 Position Tips

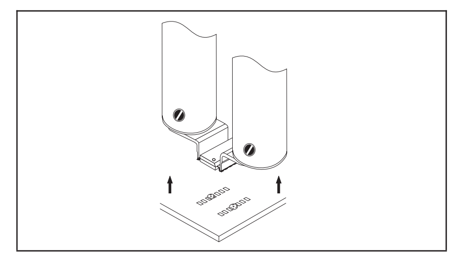


Figure 4 Lift Component

Number: **3.6.6**	Subject: **Gull Wing Removal (two-sided)**
Revision: **A** Date: 10/03	

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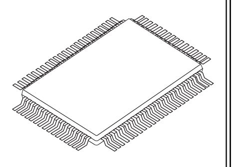
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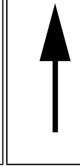
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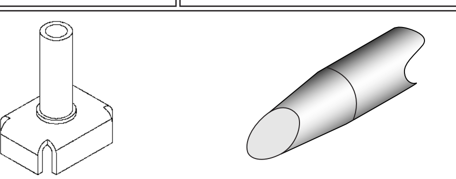
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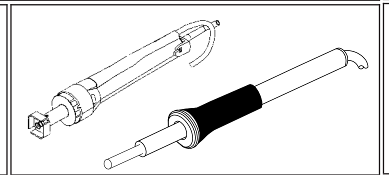
Gull Wing Removal (four-sided)

Bridge Fill Method – Vacuum Cup









Product Class: R, F, W, C
Skill Level: Advanced
Level of Conformance: High

EQUIPMENT REQUIRED

Soldering system
Vacuum handpiece
Removal tip
Broad surfaced tip

MATERIALS

Flux-cored solder
Cleaner

PROCEDURE

1. Remove conformal coating (if any) and clean work area of any contamination, oxides or residues.
2. Install broad-surface tip.
3. Install vacuum cup onto vacuum tube of handpiece.
4. Start with tip temperature of approximately 315°C and change as necessary.
5. Install removal tip.
6. Using soldering handpiece, melt solder to form a solder bridge fill joining all component leads. (See Figure 1.)
7. Remove old solder from tip.
8. Thermal shock tip with damp sponge.
9. Tin bottom edge of tip with solder. (See Figure 2.)
10. Gently lower tip over component, contacting ALL leads. (See Figures 3 & 4.)
11. Confirm solder melt of ALL joints, actuate vacuum and lift component from PWB. (See Figures 4 & 5.)
12. Release component onto a heat resistant surface.
13. Re-tin tip with solder.
14. Prepare lands for component replacement.

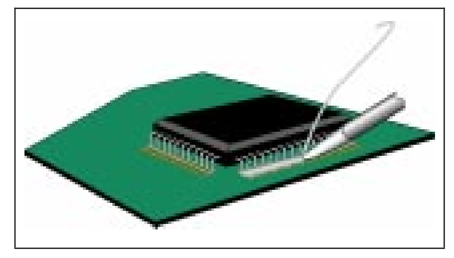


Figure 1 Bridge Fill

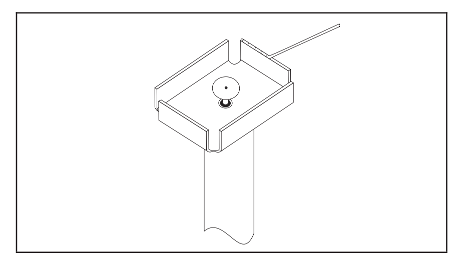


Figure 2 Tin Tip

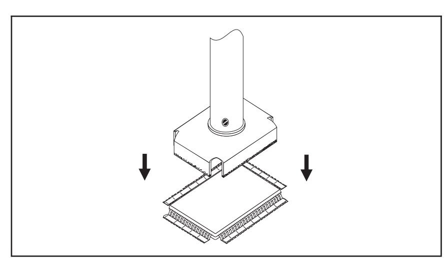


Figure 3 Position Tip

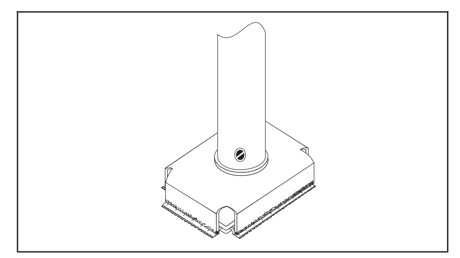


Figure 4 Melt all Joints

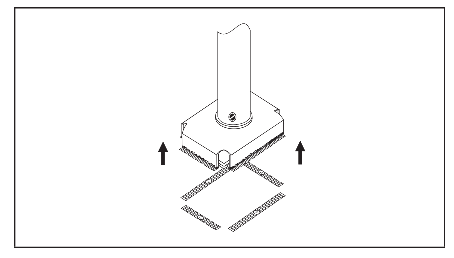


Figure 5 Lift Component

NOTES



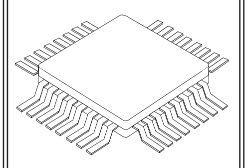
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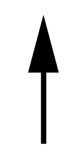
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Date: 2/98

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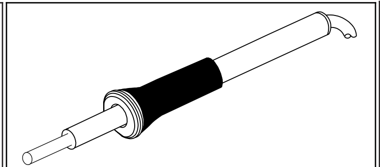
Gull Wing Removal (four-sided)

Bridge Fill Method – Surface Tension









Product Class: R, F, W, C
Skill Level: Intermediate
Level of Conformance: High

EQUIPMENT REQUIRED

Soldering system
Soldering handpiece
Removal tip
Broad surface tip

OPTIONAL EQUIPMENT

Tweezers

MATERIALS

Flux-cored solder
Cleaner

PROCEDURE

1. Remove conformal coating (if any) and clean work area of any contamination, oxides or residues.
2. Install broad surfaced tip into soldering handpiece.
3. Start with tip temperature of approximately 315°C and change as necessary.
4. Using soldering handpiece, melt solder to form a solder bridge fill, joining all component leads. (See Figure 1.)
5. Replace broad surfaced tip in soldering handpiece with removal tip.
6. Remove old solder from tip and thermal shock tip with damp sponge.
7. Tin bottom and inside edges of tip with solder. (See Figure 2.)
8. Lower tip over component contacting ALL leads with tip. (See Figures 3 & 4.)
9. Confirm solder melt of ALL joints and lift component from PWB. (See Figures 4 & 5.) (Surface tension of the tip should lift the component from the board. If this does not occur, use of tweezers to lift the component is optional.)
10. Release component from tip by wiping on a heat resistant surface.
11. Re-tin tip with solder.
12. Prepare lands for component replacement.

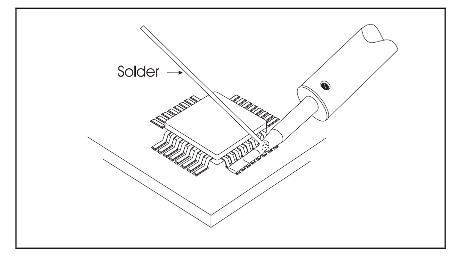


Figure 1 Bridge Fill

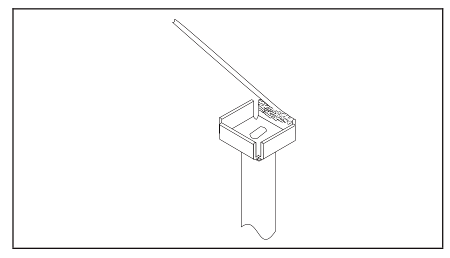


Figure 2 Tin Tip

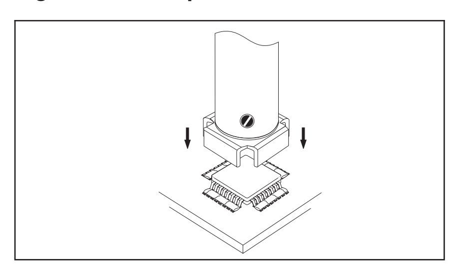


Figure 3 Position Tip

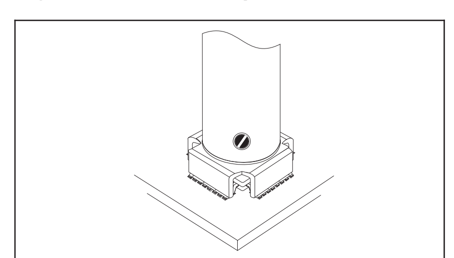


Figure 4 Melt All Joints

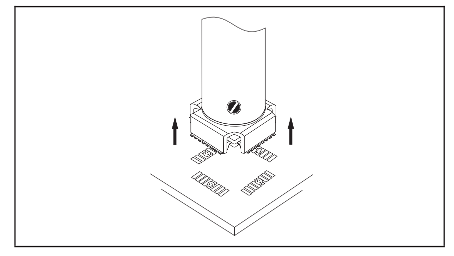


Figure 5 Lift Component

NOTES



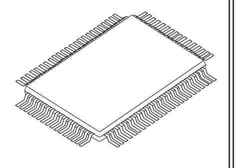
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Rework of
Electronic Assemblies

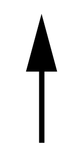
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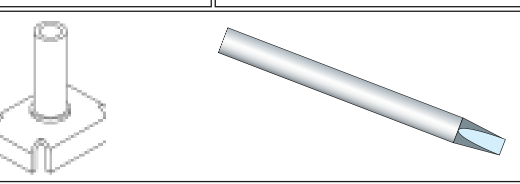
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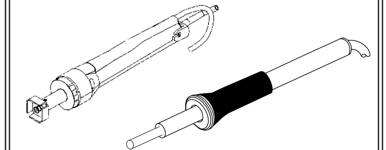
Gull Wing Removal (four-sided)

Solder Wrap Method – Vacuum Cup









Product Class: R, F, W, C
Skill Level: Advanced
Level of Conformance: High

EQUIPMENT REQUIRED

Soldering system
Vacuum handpiece
Removal tip
Chisel tip

MATERIALS

Flux-cored solder
Cleaner

PROCEDURE

1. Remove conformal coating (if any) and clean work area of any contamination, oxides or residues.
2. Install removal tip.
3. Install vacuum cup onto vacuum tube of handpiece.
4. Start with tip temperature of approximately 315°C and change as necessary.
5. Tack solder to one of the corner component leads using the soldering handpiece with a chisel tip installed. Wrap solder around the four sides of the component. Tack solder at the end of the last side. (See Figure 1.)
6. Remove old solder from tip.
7. Thermal shock tip with damp sponge.
8. Tin bottom edge of the tip with solder. (See Figure 2.)
9. Gently lower tip over component, contacting ALL the leads. (See Figures 3 & 4.)
10. Confirm solder melt of ALL joints, actuate vacuum and lift component from PWB. (See Figures 4 & 5.)
11. Release component onto a heat resistant surface.
12. Re-tin tip with solder.
13. Prepare lands for component replacement.

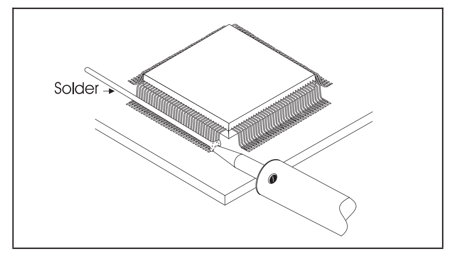


Figure 1 Tack and Wrap Solder

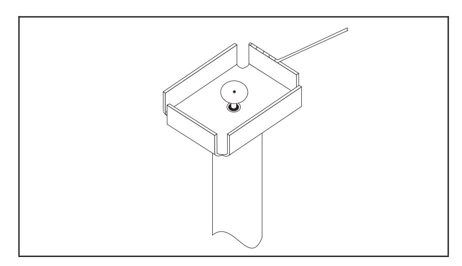


Figure 2 Tin Tip

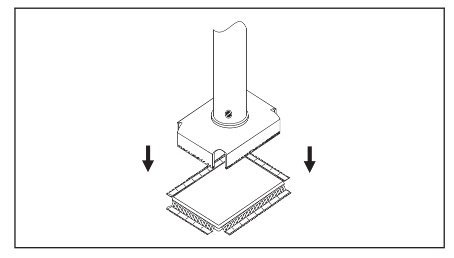


Figure 3 Position Tip

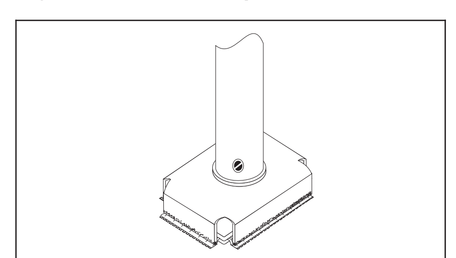


Figure 4 Melt All Joints

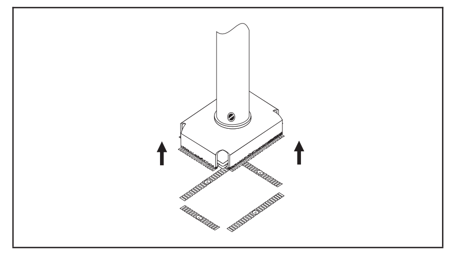


Figure 5 Lift Component

NOTES



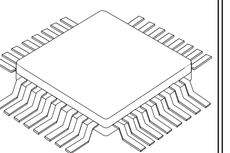
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Rework of
Electronic Assemblies

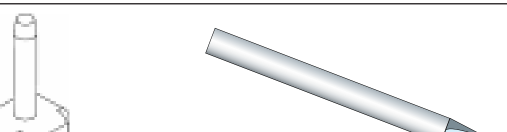
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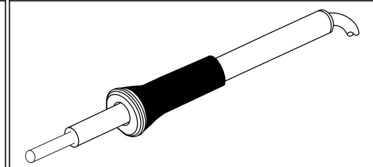
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Gull Wing Removal (four-sided)

Solder Wrap Method – Surface Tension







Product Class: R, F, W, C
Skill Level: Intermediate
Level of Conformance: High

EQUIPMENT REQUIRED

Soldering system
Removal tip
Chisel tip

OPTIONAL EQUIPMENT

Tweezers

MATERIALS

Flux-cored solder
Cleaner

PROCEDURE

1. Remove conformal coating (if any) and clean work area of any contamination, oxides or residues.
2. Install chisel tip into soldering handpiece.
3. Start with tip temperature of approximately 315°C and change as necessary.
4. Tack solder to one of the corner component leads using soldering handpiece with chisel tip installed. Wrap solder around the four sides of component. Terminate solder at the end of last side using soldering handpiece. (See Figure 1.)
5. Replace chisel tip in soldering handpiece with removal tip.
6. Remove old solder from tip and thermal shock tip with damp sponge.
7. Tin bottom and inside edges of tip with solder. (See Figure 2.)
8. Lower tip over component contacting ALL leads with tip. (See Figures 3 & 4.)
9. Confirm solder melt of ALL joints and lift component from PWB. (See Figure 5.) (Surface tension of the tip should lift the component from the board. If this does not occur, use of tweezers to lift the component is optional.)
10. Release component from tip by wiping on a heat resistant surface.
11. Re-tin tip with solder.
12. Prepare lands for component replacement.

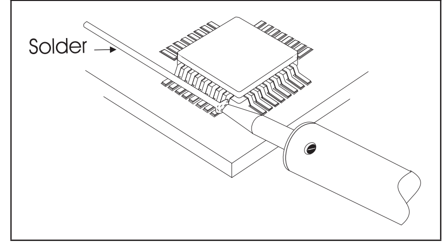


Figure 1 Tack and Wrap Solder

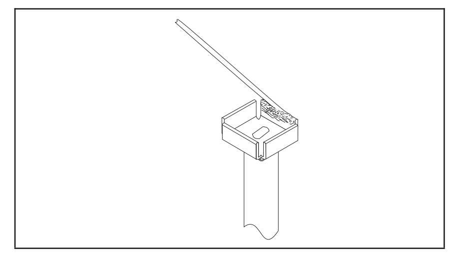


Figure 2 Tin Tip

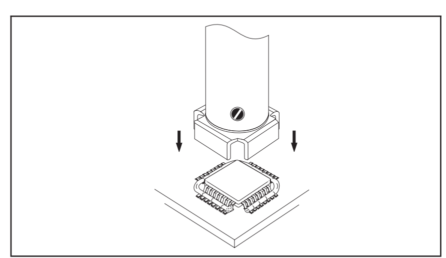


Figure 3 Position Tip

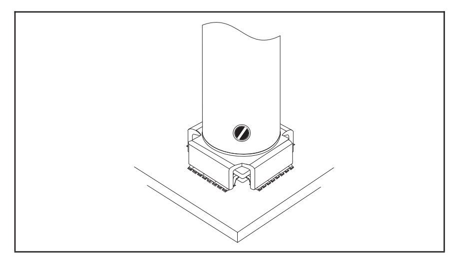


Figure 4 Melt All Joints

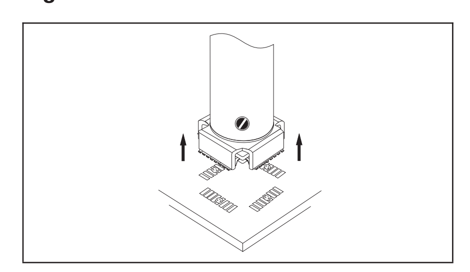


Figure 5 Lift Component

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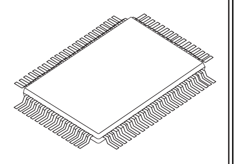
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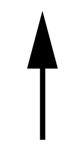
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Date: 2/98

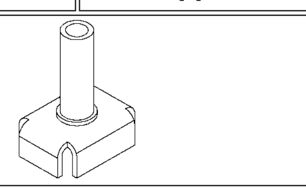
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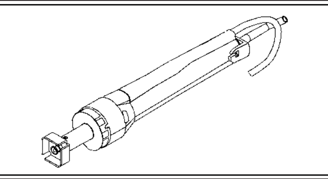
Gull Wing Removal (four-sided)

Flux Application Method – Vacuum Cup









Product Class: R, F, W, C
Skill Level: Advanced
Level of Conformance: High

EQUIPMENT REQUIRED

Soldering system
Vacuum handpiece
Removal tip

MATERIALS

Flux-cored solder
Cleaner
Flux

PROCEDURE

1. Remove conformal coating (if any) and clean work area of any contamination, oxides or residues.
2. Install removal tip.
3. Install vacuum cup onto vacuum tube of handpiece.
4. Start with tip temperature of approximately 315°C and change as necessary.
5. Apply flux to all lead/land areas. (See Figure 1.)
6. Remove older solder from tip.
7. Thermal shock tip with damp sponge.
8. Tin bottom edge of the tip with solder. (See Figure 2.)
9. Gently lower tip over component, contacting ALL the leads. (See Figures 3 & 4.)
10. Confirm solder melt of ALL joints, actuate vacuum and lift component from PWB. (See Figures 4 & 5.)
11. Release component onto a heat resistant surface.
12. Re-tin tip with solder.
13. Prepare lands for component replacement.

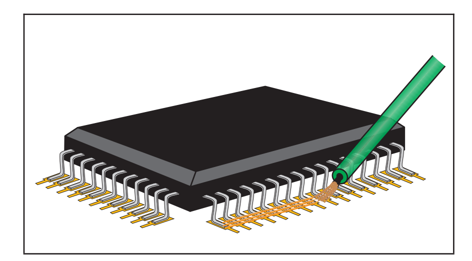


Figure 1 Flux Component

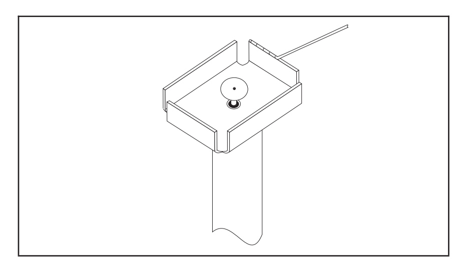


Figure 2 Tin Tip

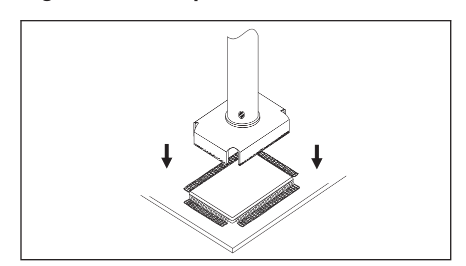


Figure 3 Position Tip

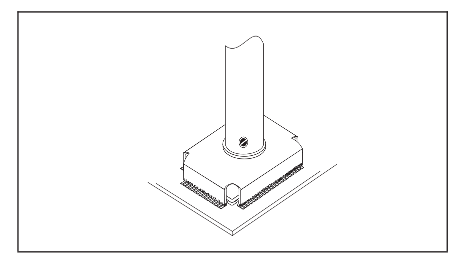


Figure 4 Melt All Joints

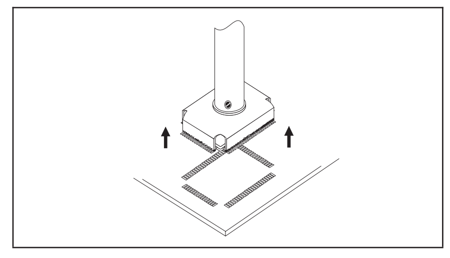


Figure 5 Lift Component

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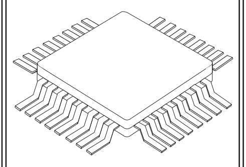
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Rework of
Electronic Assemblies

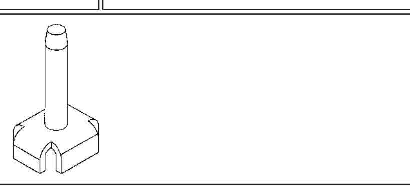
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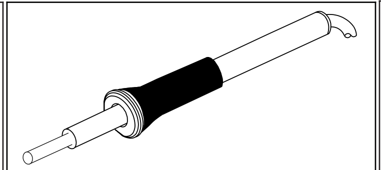
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Gull Wing Removal (four-sided)

Flux Application Method – Surface Tension







Product Class: R, F, W, C
Skill Level: Intermediate
Level of Conformance: High

EQUIPMENT REQUIRED

Soldering system
Soldering handpiece
Removal tip

OPTIONAL EQUIPMENT

Tweezers

MATERIALS

Flux-cored solder
Flux
Cleaner

PROCEDURE

1. Remove conformal coating (if any) and clean work area of any contamination, oxides or residues.
2. Install removal tip into soldering handpiece.
3. Start with tip temperature of approximately 315°C and change as necessary.
4. Apply flux to all lead/land areas. (See Figure 1.)
5. Remove old solder from tip and thermal shock tip with damp sponge.
6. Tin bottom and inside edges of tip with solder. (See Figure 2.)
7. Lower tip over component contacting ALL leads with tip. (See Figures 3 & 4.)
8. Confirm solder melt of ALL joints and lift component from PWB. (See Figures 4 & 5.) (Surface tension of the tip should lift the component from the board. If this does not occur, use of tweezers to lift the component is optional.)
9. Release component from tip by wiping on a heat resistant surface.
10. Re-tin tip with solder.
11. Prepare lands for component replacement.

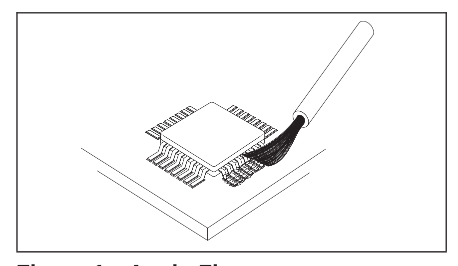


Figure 1 Apply Flux

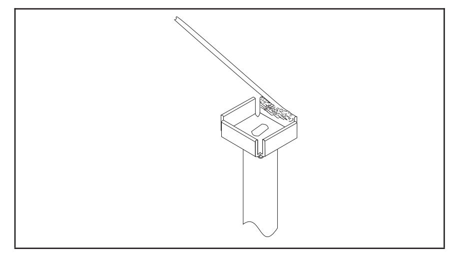


Figure 2 Tin Tip

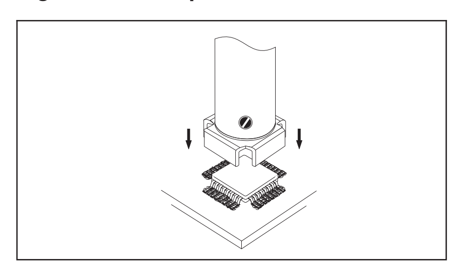


Figure 3 Position Tip

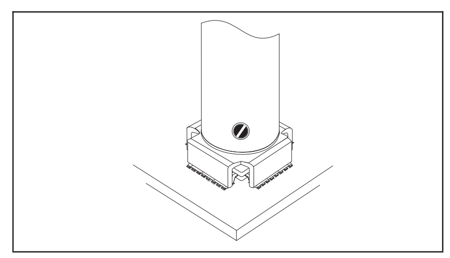


Figure 4 Melt All Joints

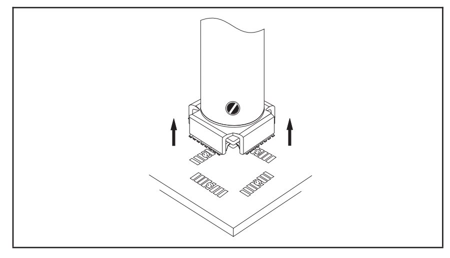


Figure 5 Lift Component

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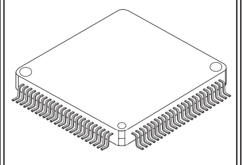
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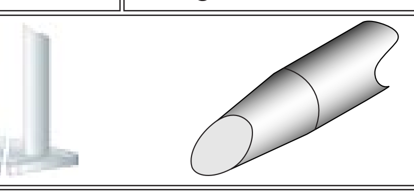
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Date: 10/03

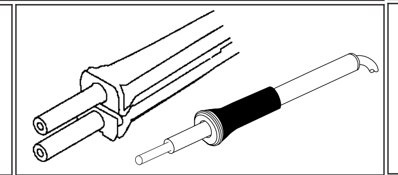
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Gull Wing Removal (four-sided)

Bridge Fill Method – Tweezer







Product Class: R, F, W, C
Skill Level: Advanced
Level of Conformance: High

EQUIPMENT REQUIRED

Soldering handpiece
Soldering system
Tweezer handpiece
Removal tips
Broad surfaced tip

MATERIALS

Flux-cored solder
Cleaner

PROCEDURE

1. Remove conformal coating (if any) and clean work area of any contamination, oxides or residues.
2. Install removal tips into tweezer handpiece.
3. Start with tip temperature of approximately 315°C and change as necessary.
4. Using soldering handpiece, melt solder to form a solder bridge fill, joining all component leads. (See Figure 1.)
5. Remove old solder from tips and thermal shock tips with damp sponge.
6. Tin bottom edges of tips with solder. (See Figure 2.)
7. Lower tips over component and squeeze handpiece, contacting ALL leads with tips. (See Figures 3 & 4.)
8. Confirm solder melt of ALL joints and lift component from PWB. (See Figures 4 & 5.)
9. Release component onto a heat resistant surface.
10. Re-tin tips with solder.
11. Prepare lands for component replacement.

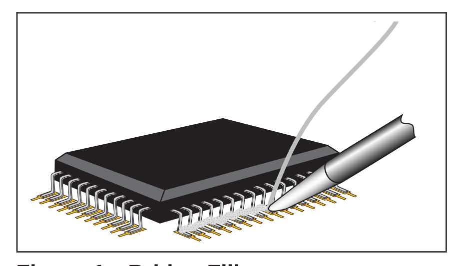


Figure 1 Bridge Fill

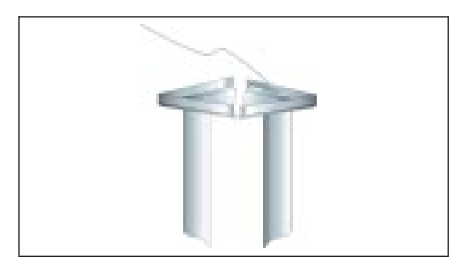


Figure 2 Tin Tips

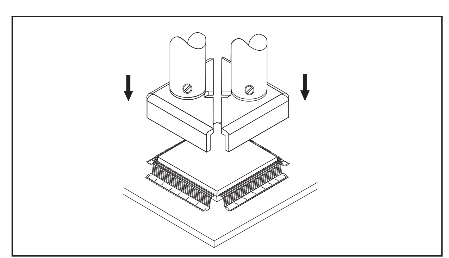


Figure 3 Position Tips

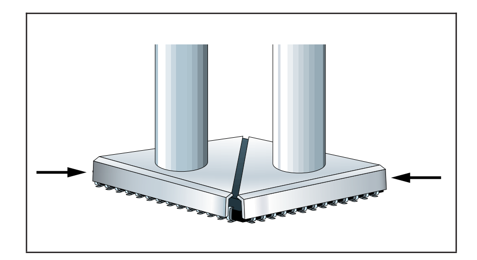


Figure 4 Melt All Joints

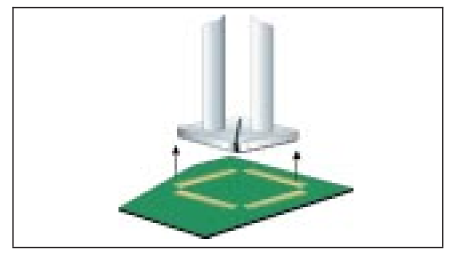


Figure 5 Lift Component

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Rework of
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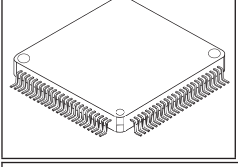
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Date: 10/03

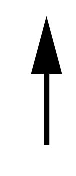
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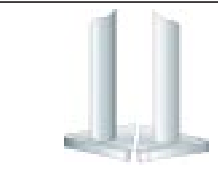
Gull Wing Removal (four-sided)

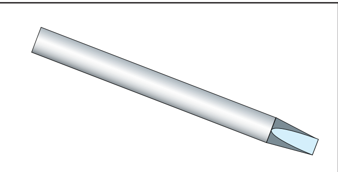
Solder Wrap Method – Tweezer

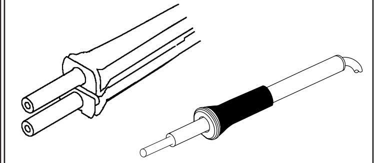












Product Class: R, F, W, C
Skill Level: Advanced
Level of Conformance: High

EQUIPMENT REQUIRED

Soldering handpiece
Soldering system
Tweezer handpiece
Removal tips
Chisel tip

MATERIALS

Flux-cored solder
Cleaner

PROCEDURE



1. Remove conformal coating (if any) and clean work area of any contamination, oxides or residues.
2. Install removal tips into tweezer handpiece and chisel tip into soldering handpiece.
3. Start with tip temperature of approximately 315°C and change as necessary.
4. Tack solder to one of the corner component leads using the soldering handpiece with a chisel tip installed. Wrap solder around the four sides of the component. Tack solder at the end of the last side. (See Figure 1.)
5. Remove old solder from tips and thermal shock tips with damp sponge.
6. Tin bottom and inside edges of tips with solder. (See Figure 2.)
7. Lower tips over component and squeeze handpiece, contacting ALL leads with tips. (See Figures 3 & 4.)
8. Confirm solder melt of ALL joints and lift component from PWB. (See Figures 4 & 5.)
9. Release component onto a heat resistant surface.
10. Re-tin tips with solder.
11. Prepare lands for component replacement.

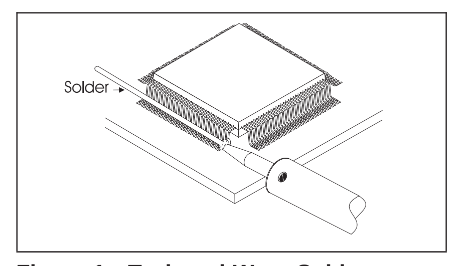


Figure 1 Tack and Wrap Solder

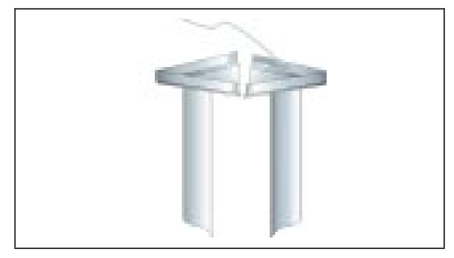


Figure 2 Tin Tips

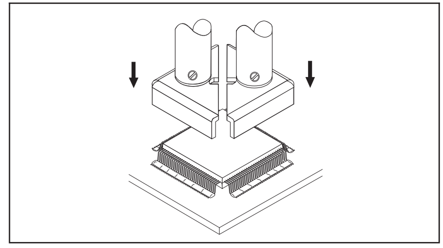


Figure 3 Position Tips

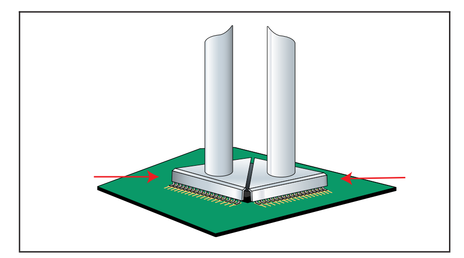


Figure 4 Melt All Joints

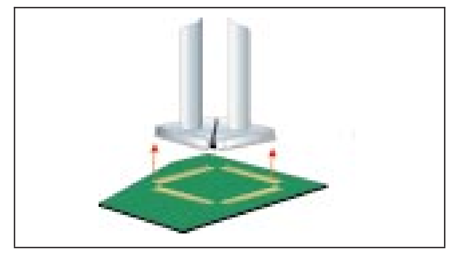


Figure 5 Lift Component

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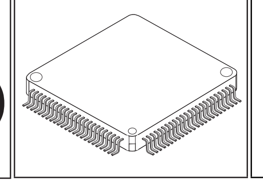
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Electronic Assemblies

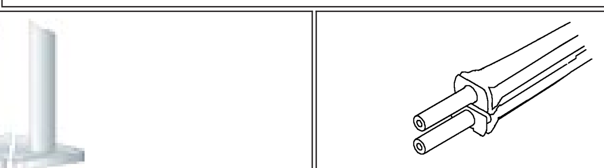
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Date: 2/98

Number: **3.7.6**

Gull Wing Removal (four-sided)

Flux Application Method – Tweezer





Product Class: R, F, W, C
Skill Level: Advanced
Level of Conformance: High

EQUIPMENT REQUIRED

Soldering system
Tweezer handpiece
Removal tips

MATERIALS

Flux-cored solder
Cleaner
Flux

PROCEDURE

1. Remove conformal coating (if any) and clean work area of any contamination, oxides or residues.
2. Install removal tips into tweezer handpiece.
3. Start with tip temperature of approximately 315°C and change as necessary.
4. Apply flux to component lead/land areas. (See Figure 1.)
5. Remove old solder from tips and thermal shock tips with damp sponge.
6. Tin bottom edges of tips with solder. (See Figure 2.)
7. Lower tips over component and squeeze handpiece, contacting ALL leads with tips. (See Figures 3 & 4.)
8. Confirm solder melt of ALL joints and lift component from PWB. (See Figures 4 & 5.)
9. Release component onto a heat resistant surface.
10. Re-tin tips with solder.
11. Prepare lands for component replacement.

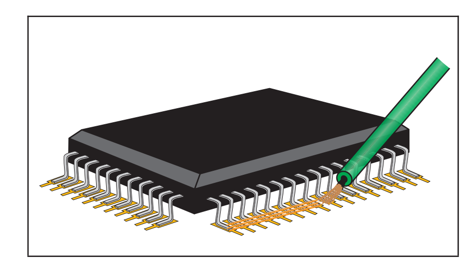


Figure 1 Flux Component

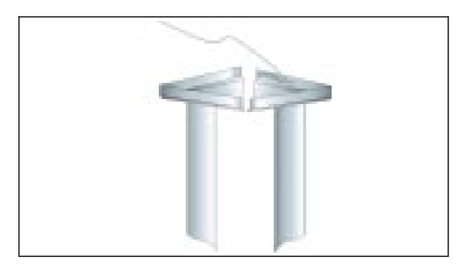


Figure 2 Tin Tips

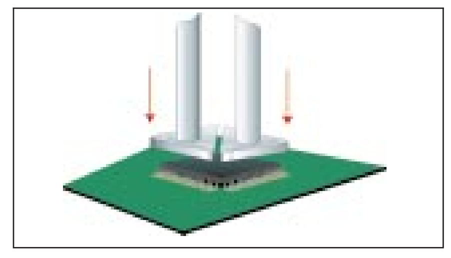


Figure 3 Position Tips

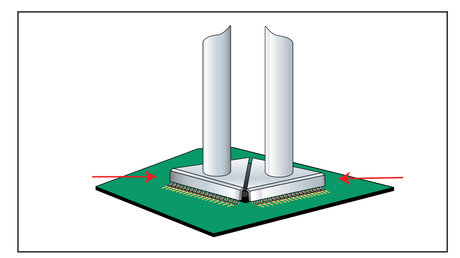


Figure 4 Melt All Joints

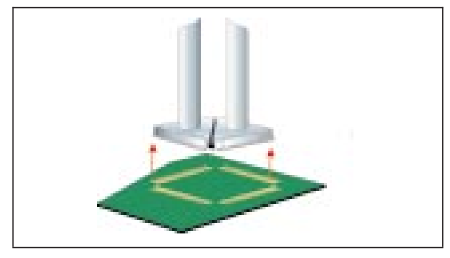
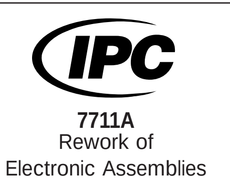


Figure 5 Lift Component

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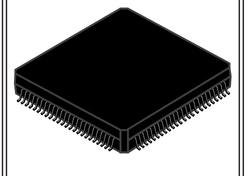
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Electronic Assemblies

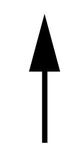
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Date: 2/98

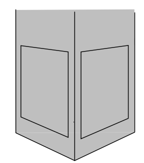
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Gull Wing Removal (four-sided)

Hot Gas (Air) Reflow Method







Product Class: R, F, W, C
Skill Level: Advanced
Level of Conformance: High

EQUIPMENT REQUIRED

Hot gas (air) reflow system
Nozzle

MATERIALS

Cleaner
Flux

PROCEDURE

1. Remove conformal coating (if any) and clean work area of any contamination, oxides or residues.
2. Install nozzle into the hot gas reflow system and raise nozzle to highest position. Place PWB assembly onto the work platform.
3. Set system controls to the required settings to optimize performance.
4. Apply flux to component leads. (See Figure 1.)
5. Position component to be removed under nozzle. (See Figure 2.)
6. Lower nozzle and check alignment and make adjustments as needed. (See Figure 3.)
7. Position nozzle to expose vacuum cup. Turn on vacuum and lower vacuum cup until it touches component.
8. Lower nozzle to component and commence reflow cycle and observe solder melt of all leads. (See Figure 4.)
9. Upon completion of the reflow cycle, raise nozzle and allow component to cool prior to board removal from work platform. (See Figure 5.)

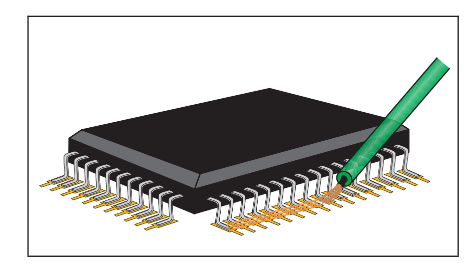


Figure 1 Flux Component

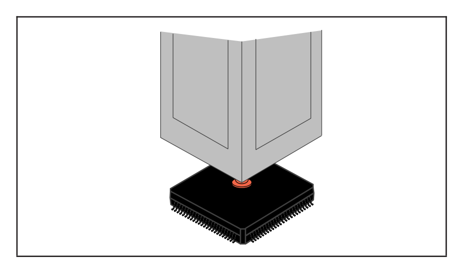


Figure 2 Position Component

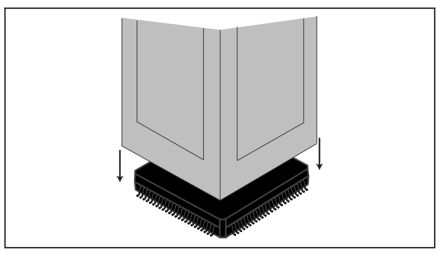


Figure 3 Lower Nozzle

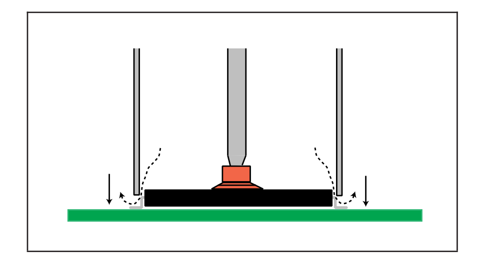


Figure 4 Melt All Joints

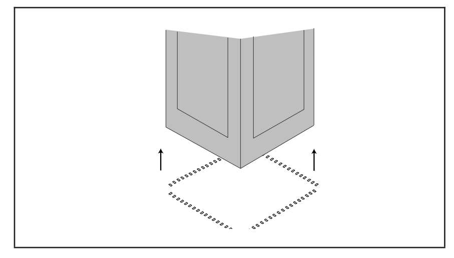


Figure 5 Lift Component

Number: **3.7.7**	Subject: **Gull Wing Removal (four-sided)**
Revision: Date: 2/98	

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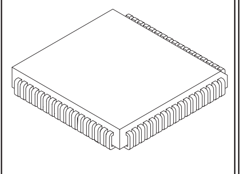
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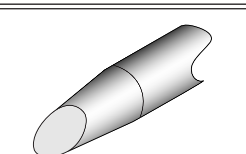
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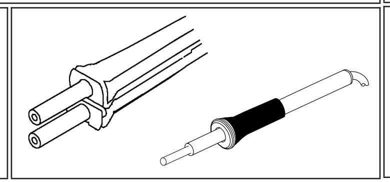
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J-Lead Removal (four sided)

Bridge Fill Method - Tweezer







Product Class: R, F, W, C
Skill Level: Advanced
Level of Conformance: High

EQUIPMENT REQUIRED

Soldering system
Tweezer handpiece
Removal tips
Board surface tip
Soldering handpiece

MATERIALS

Flux-cored solder
Cleaner

PROCEDURE

1. Remove conformal coating (if any) and clean work area of any contamination, oxides or residues.
2. Install removal tips into tweezer handpiece.
3. Start with tip temperature of approximately 315°C and change as necessary.
4. Using soldering handpiece, melt solder to form a solder bridge fill joining all component leads. (See Figure 1.)
5. Remove old solder from tips and thermal shock tips with damp sponge.
6. Tin inside edges of tips with solder. (See Figure 2.)
7. Lower tips over component and squeeze handpiece. (See Figures 3 & 4.)
8. Contact ALL leads with tips, confirm solder melt of ALL joints and lift component from PWB. (See Figures 4 & 5.)
9. Release component onto a heat resistant surface.
10. Re-tin tips with solder.
11. Prepare lands for component replacement.

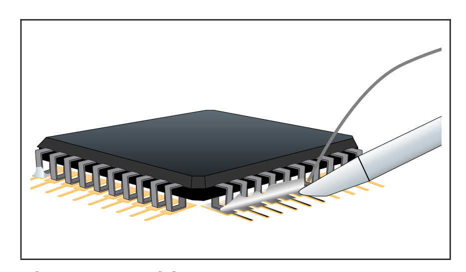


Figure 1 Bridge

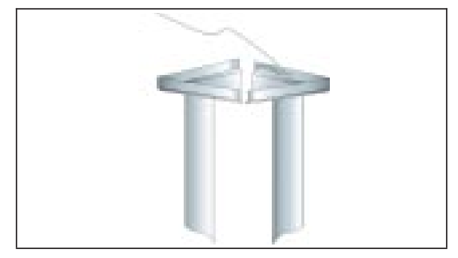


Figure 2 Tin Tips

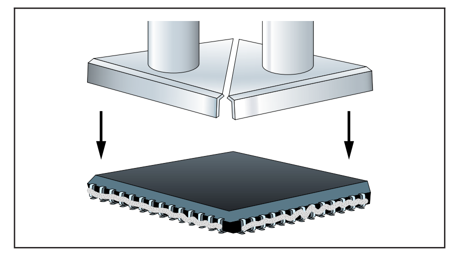


Figure 3 Position Tips

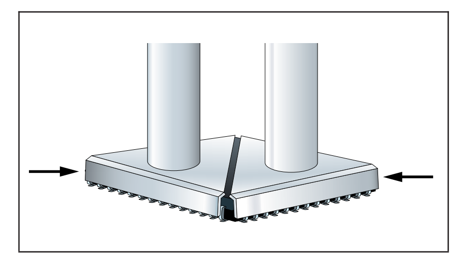


Figure 4 Melt Joints

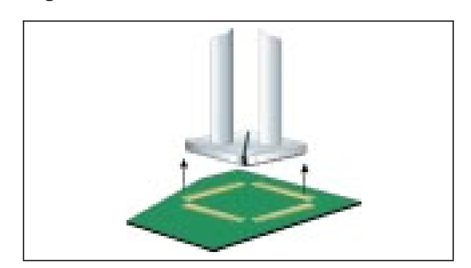


Figure 5 Lift Component

Number: **3.8.1**	Subject: **J-Lead Removal (four sided)**
Revision: Date: 2/98	

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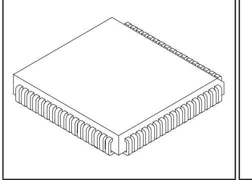
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Electronic Assemblies

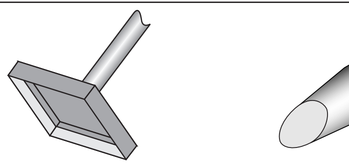
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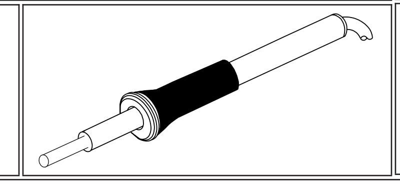
Number: **3.8.1.1**

J-Lead Removal

Bridge Fill Method – Surface Tension







Product Class: R, F, W, C
Skill Level: Advanced
Level of Conformance: High

EQUIPMENT REQUIRED

Soldering system(s)
1 or 2 Soldering handpieces
Fixed head PLCC removal tip
Broad surface tip

MATERIALS

Solder wire
Flux

PROCEDURE

1. Remove conformal coating (if any) and clean work area of any contamination, oxides, or residues.
2. Install tip.
3. Start with tip temperature of approximately 315°C and change as necessary.
4. Using broad surface tip, melt solder around the outside of the leads, creating an even, solid bridge across the entire row. (See Figure 1.)
5. Install and clean the inside edges of the PLCC removal tip.
6. Tin the tip evenly around the inside edge, ensuring that there is good wetting all the way around. (See Figure 2.)
7. Apply flux to all the leads. (See Figure 3.)
8. Bring the tip straight down on the component, contacting all the leads evenly. (See Figure 4.)
9. Wait for full reflow, displace the leads from the pads to break surface tension, and lift straight up. (See Figure 5.)
10. Immediately remove the component from the tip.
11. Prepare the lands for component replacement.

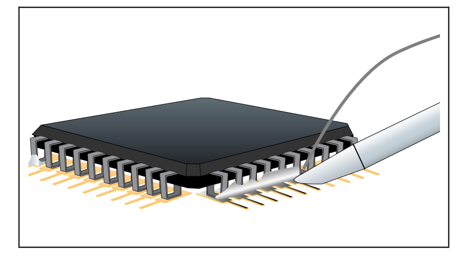


Figure 1 Melt Solder

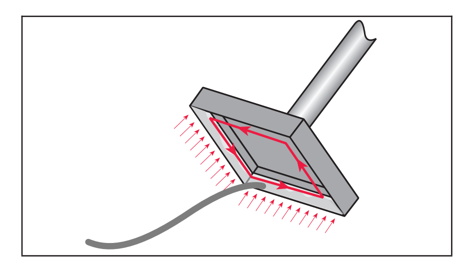


Figure 2 Tin Tip

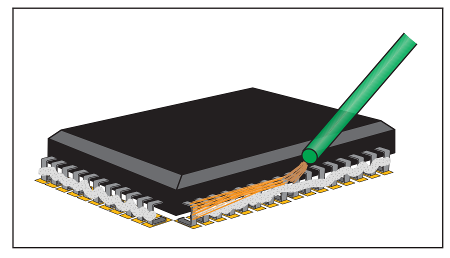


Figure 3 Apply Flux

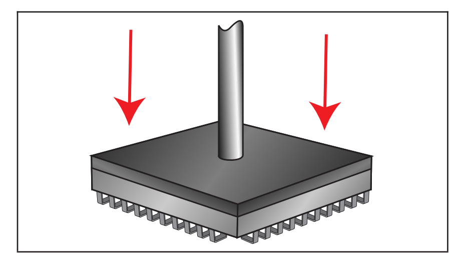


Figure 4 Melt Solder

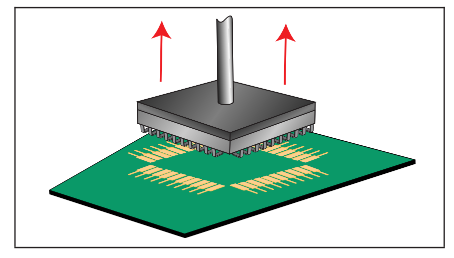


Figure 5 Lift Component

Number: **3.8.1.1**	Subject: **J-Lead Removal**
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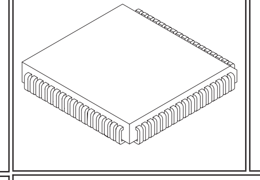
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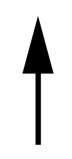
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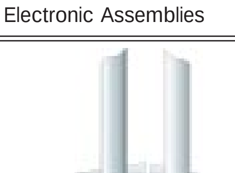
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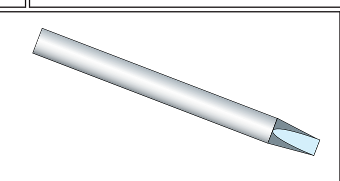
J-Lead Removal (four-sided)

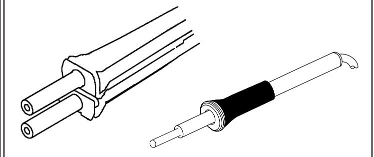
Solder Wrap Method – Tweezer











Product Class: R, F, W, C
Skill Level: Advanced
Level of Conformance: High

EQUIPMENT REQUIRED

Soldering system
Tweezer handpiece
Removal tips
Soldering handpiece
Chisel tip

MATERIALS

Flux-cored solder
Cleaner

PROCEDURE



1. Remove conformal coating (if any) and clean work area of any contamination, oxides or residues.
2. Install and align removal tips into tweezer handpiece.
3. Start with tip temperature of approximately 315°C and change as necessary.
4. Tack solder to one of the corner component leads using soldering handpiece with chisel tip installed. (See Figure 1.)
5. Wrap solder around the four sides of component.
6. Terminate solder at the end of last side using soldering handpiece.
7. Remove old solder from removal tips and thermal shock tips with damp sponge.
8. Tin inside edges of tips with solder. (See Figure 2.)
9. Lower tips over component and squeeze handpiece. (See Figures 3 & 4.)
10. Contact ALL leads with tips, confirm solder melt of ALL joints and lift component from PWB. (See Figures 4 & 5.)
11. Release component onto a heat resistant surface.
12. Re-tin tips with solder.
13. Prepare lands for component replacement.

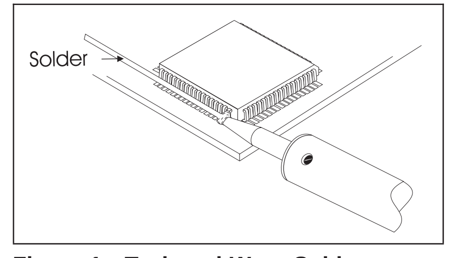


Figure 1 Tack and Wrap Solder

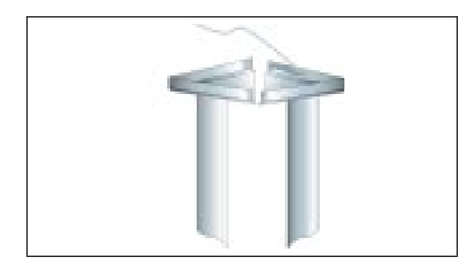


Figure 2 Tin Tips

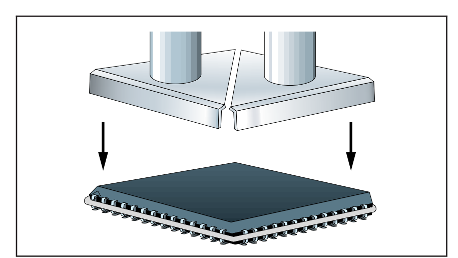


Figure 3 Position Tips

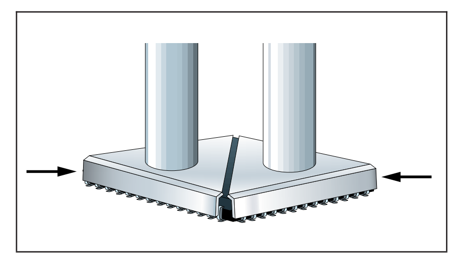


Figure 4 Melt All Joints

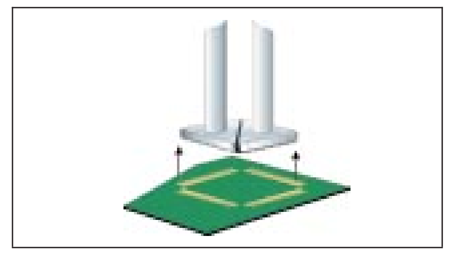


Figure 5 Lift Component

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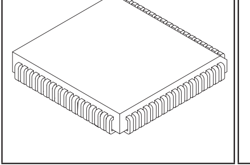
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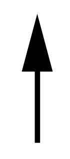
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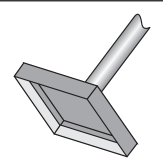
Number: **3.8.2.1**

J-Lead Removal

Solder Wrap Method – Surface Tension







Product Class: R, F, W, C
Skill Level: Advanced
Level of Conformance: High

EQUIPMENT REQUIRED

Soldering system(s)
1 or 2 Soldering handpieces
Single or dual shaft J-Lead removal tip

MATERIALS

Solder wire
Flux

PROCEDURE

1. Remove conformal coating (if any) and clean work area of any contamination, oxides or residues.
2. Select the proper tip by using the manufacturer's recommended tip selection guides. Install tip.
3. Start with tip temperature of approximately 315°C and change as necessary.
4. Remove old solder from removal tips and thermal shock tip with damp sponge.
5. Wrap a length of .025 or .031 gauge wire solder once around the leads of the component. (See Figure 1.)
6. Ensure that there's good wetting all the way around the inside of the tip. If there's not good wetting all around, or if the inside edge of the tip is discolored, use the manufacturer's recommended methods and/or tools to clean the tip.
7. Tin the tip generously around the entire inside working surface. (See Figure 2.)
8. Apply flux to all the leads. (See Figure 3.)
9. Bring the tip straight down on top of the part, making full, even contact on all of the leads. (See Figure 4.)
10. When the component leads have reflowed, slide the tip to one side just slightly, or twist it slightly, and lift straight up. (See Figure 5.)
11. Remove the component immediately by wiping it on the sponge.

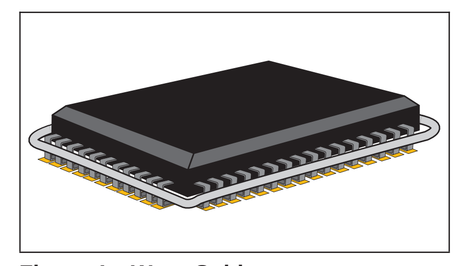


Figure 1 Wrap Solder

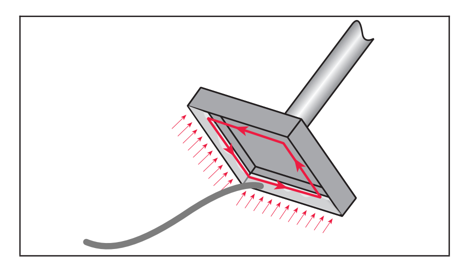


Figure 2 Tin Tip

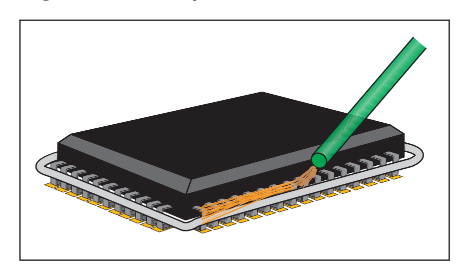


Figure 3 Apply Flux

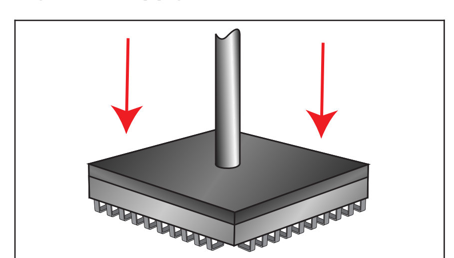


Figure 4 Contact All Leads

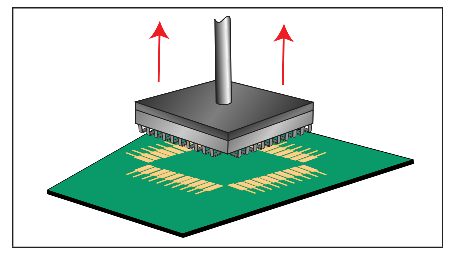


Figure 5 Lift

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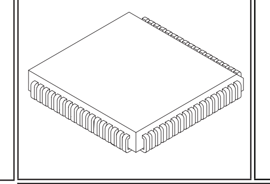
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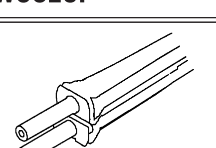
Number: **3.8.3**

J-Lead Removal (four-sided)

Flux Application Method – Tweezer



Product Class: R, F, W, C
Skill Level: Advanced
Level of Conformance: High



EQUIPMENT REQUIRED

Soldering system
Tweezer handpiece
Removal tips

MATERIALS

Flux
Flux-cored solder
Cleaner

PROCEDURE

1. Remove conformal coating (if any) and clean work area of any contamination, oxides or residues.
2. Install and align removal tips into tweezer handpiece.
3. Start with tip temperature of approximately 315°C and change as necessary.
4. Apply flux to component lead/land areas. (See Figure 1.)
5. Remove old solder from tips and thermal shock tips with damp sponge.
6. Tin inside edges of tips with solder. (See Figure 2.)
7. Lower tips over component and squeeze handpiece. (See Figure 3.)
8. Contact ALL leads with tips, confirm solder melt of ALL joints and lift component from PWB. (See Figures 4 & 5.)
9. Release component onto a heat resistant surface.
10. Re-tin tips with solder.
11. Prepare lands for component replacement.

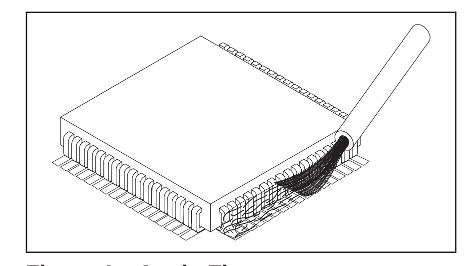


Figure 1 Apply Flux

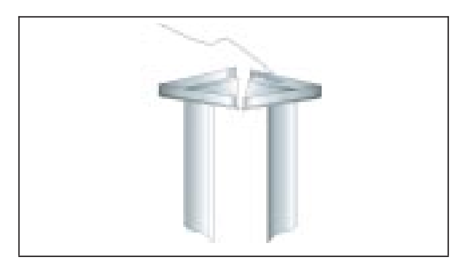


Figure 2 Tin Tips

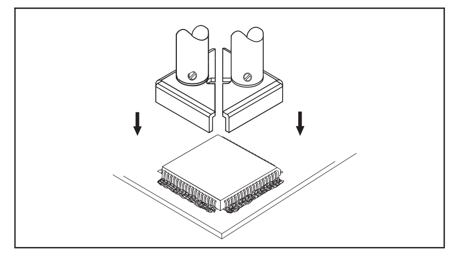


Figure 3 Position Tips

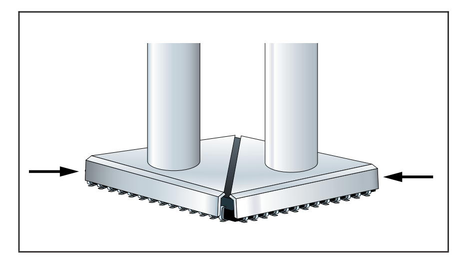


Figure 4 Melt All Joints

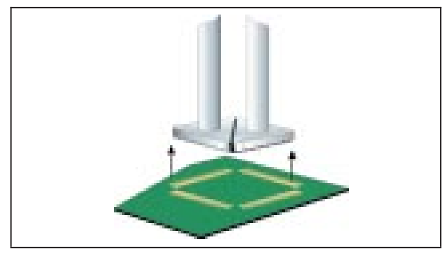


Figure 5 Lift Component

Number: **3.8.3**	Subject: **J-Lead Removal (four-sided)**
Revision: Date: 2/98	

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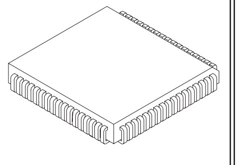
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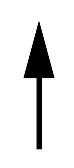
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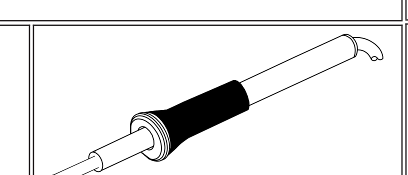
Number: **3.8.4**

J-Lead Removal

Flux & Tin Tip Only







Product Class: R, F, W, C
Skill Level: Advanced
Level of Conformance: High

EQUIPMENT REQUIRED

Soldering system(s)
1 or 2 Soldering handpieces
J-Lead removal tip

MATERIALS

Flux-cored solder
Flux

NOTES

This procedure is designed for smaller J-LEAD packages. This method is not suitable for J-LEAD 68 and larger, which are more safely removed using the wire wrap methods. The heat sinking characteristics of the component and connections will affect the choice of methods as well.

PROCEDURE

1. Remove conformal coating (if any) and clean work area of any contamination, oxides or residues.
2. Select the proper tip by using the manufacturer's recommended tip selection guides. Install tip.
3. Start with tip temperature of approximately 315°C and change as necessary.
4. Ensure that there's good wetting all the way around the inside of the tip. If there's not good wetting all around, or if the inside edge of the tip is discolored, use the manufacturer's recommended methods and/or tools to clean the tip.
5. Tin the tip generously around the entire inside working surface. (See Figure 1.)
6. Apply flux to all the leads. (See Figure 2.)
7. Bring the tip straight down on top of the part, making full, even contact on all of the leads. (See Figure 3.)
8. When the component leads have reflowed, slide the tip to one side just slightly, or twist it slightly, and lift straight up. (See Figure 4.)
9. Remove the component immediately by wiping it on the sponge.

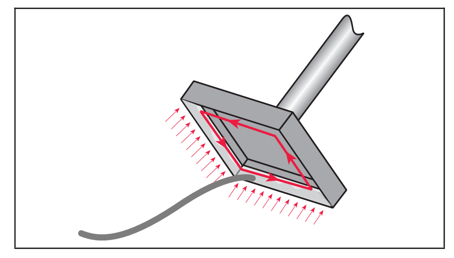


Figure 1

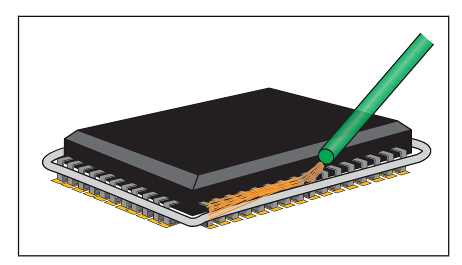


Figure 2 Apply Flux

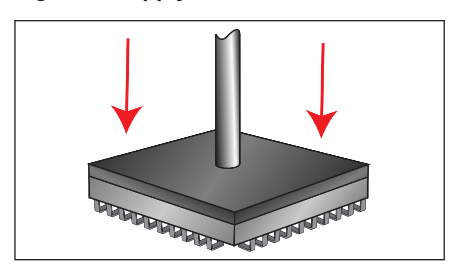


Figure 3 Contact All Leads

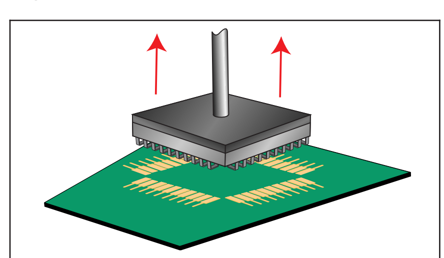


Figure 4 Slide and Lift

Number: **3.8.4**	Subject: **J-Lead Removal**
Revision: Date: 2/98	

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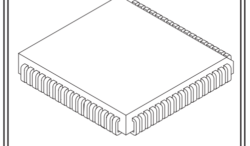
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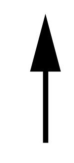
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Number: **3.8.5**

J-Lead Removal

Hot Gas Reflow System





Product Class: R, F, W, C
Skill Level: Advanced
Level of Conformance: High

EQUIPMENT REQUIRED

Hot gas (air) reflow system
Correctly sized nozzle

MATERIALS

Cleaner
Flux

PROCEDURE

1. Remove conformal coating (if any) and clean work area of any contamination, oxides or residues.
2. Install nozzle into the hot gas reflow system and raise nozzle to highest position. Place PWB assembly onto the work platform.
3. Set system controls to required settings to optimize performance.
4. Apply flux to component leads. (See Figure 1.)
5. Position component to be removed under nozzle. (See Figure 2.)
6. Lower nozzle and check alignment and make adjustments as needed. (See Figure 3.)
7. Position nozzle to expose vacuum cup. Turn on vacuum and lower vacuum cup until it touches component.
8. Lower nozzle to component and commence reflow cycle and observe solder melt of all leads. (See Figure 4.)
9. Upon completion of reflow cycle, raise nozzle and allow component to cool prior to board removal from work platform. (See Figure 5.)

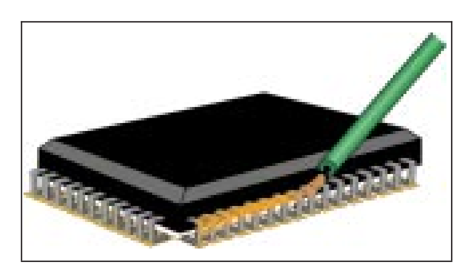


Figure 1 Flux Component

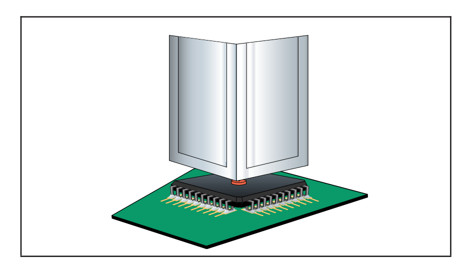


Figure 2 Position Component

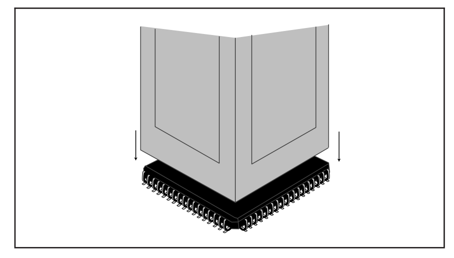


Figure 3 Lower Nozzle

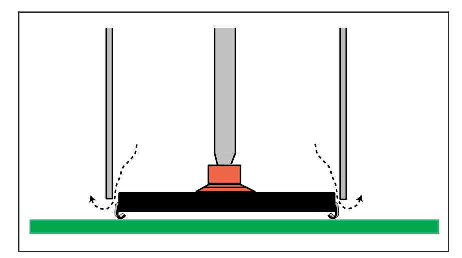


Figure 4 Melt All Joints

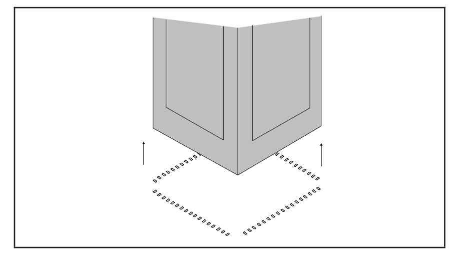


Figure 5 Lift Component

Number: **3.8.5**	Subject: **J-Lead Removal**
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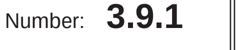


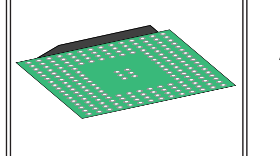
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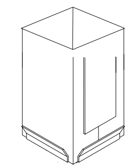
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Number: **3.9.1**

BGA/CSP Removal







Product Class: R, F, W, C
Skill Level: Advanced
Level of Conformance: High

EQUIPMENT REQUIRED

Hot air or hot gas re-flow system (representative examples shown by Figures 1-4)
Gas focusing nozzle (sized to BGA dimensions)
Gas supply (if other than ambient atmosphere)
Preheat method (oven, hotplate, high intensity lamp)

OPTIONAL EQUIPMENT

Bake-out (vacuum, convection) oven
Inert gas supply, if used

MATERIALS

Flux-cored solder
Flux
Cleaner

PROCEDURE SUMMARY

The procedure outlined below is generic in nature and identifies the procedural steps which need be accomplished to effect BGA or CSP removal. Each step must be tailored to accommodate the attributes and characteristics of the specific system being used (system manufacturers will customarily provide generalized operating procedures which must be further refined to achieve optimum results).

PROCEDURAL PRECONDITIONS

The following preconditions shall be accomplished prior to performing the procedure:

1) Develop a time/temperature profile (TTP) for the specific BGA and PWA. (See 1.9, Process Goals and Guidelines.)

NOTE: If plastic body components are used, see IPC J-STD-020 (Moisture/Reflow Sensitivity Classification for Plastic Integrated Circuit Surface Mount Devices) for information on moisture sensitivity classification tests, preconditioning, and attachment.

2) Bake the PWA to remove entrained moisture which may, if not removed, precipitate measling or delamination.

PROCEDURE STEPS

NOTE: Some systems do not include integrated preheating capability and it may be necessary to preheat the PWA and BGA separately.

1. Place the PWA in the system work piece holder.
2. Inject flux under the BGA.
3. Set hot gas re-flow system to achieve the TTP defined by procedural analysis.

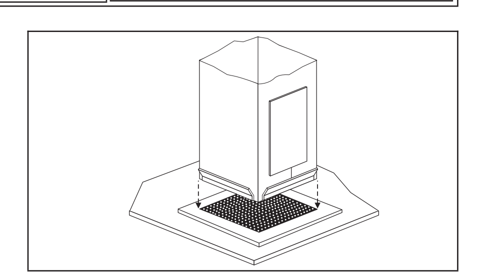


Figure 1 Align Nozzle

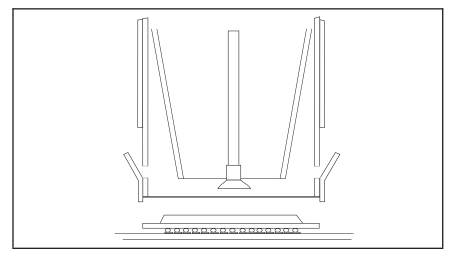


Figure 2 Lower Nozzle

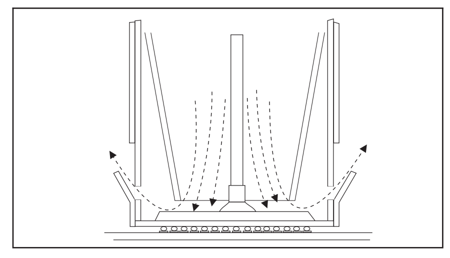


Figure 3 Nozzle to BGA

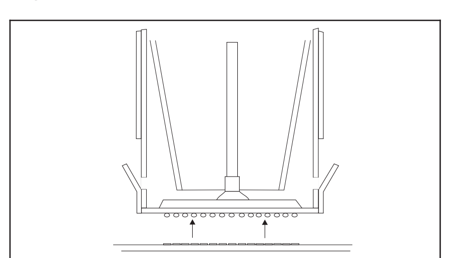


Figure 4 Raise Nozzle and BGA

4. Perform alignment of gas nozzle to component location.
5. Bring gas focusing nozzle into re-flow position.
6. Perform TTP re-flow cycle defined by procedural analysis.
7. Clean PWA as appropriate to customer requirements.



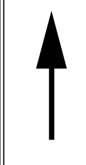
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Rework of
Electronic Assemblies

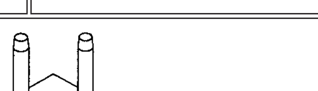
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Date: 2/98

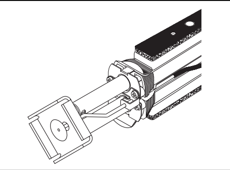
Number: **3.9.2**

BGA Removal

Vacuum Method







Product Class: R, F, W, C
Skill Level: Advanced
Level of Conformance: Medium

EQUIPMENT REQUIRED

Soldering system
Heater handpiece with vacuum cup
BGA removal tip



MATERIALS

Cleaner
Flux

PROCEDURE

1. Remove conformal coating (if any) and clean work area of any contamination, oxides or residues.
2. Install BGA removal tip and vacuum cup into dual handpiece. (See Figures 1 & 2.)
3. Start with tip temperature of approximately 371°C and change as necessary.
4. Lower tip over component. (See Figure 3.)
   NOTE: Injection of liquid flux under component may reduce cycle time.
5. Confirm solder melt of ALL joints. (See Figure 4.)
6. Actuate vacuum and lift component from PWB. (See Figure 5.)
7. Release component onto a heat resistant surface.
8. Prepare lands for component replacement.

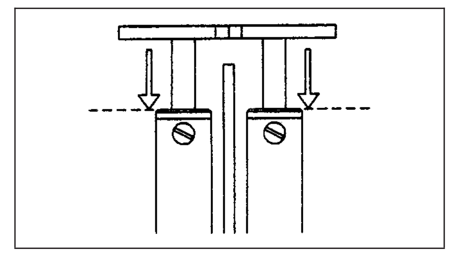


Figure 1 Install Tip

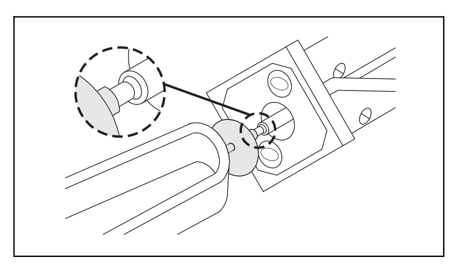


Figure 2 Install Vacuum Cup

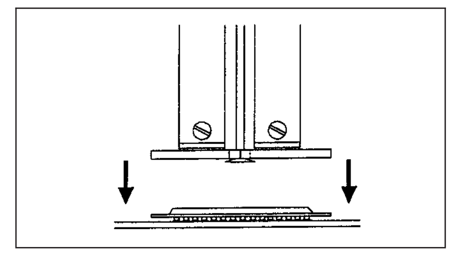


Figure 3 Position Tip

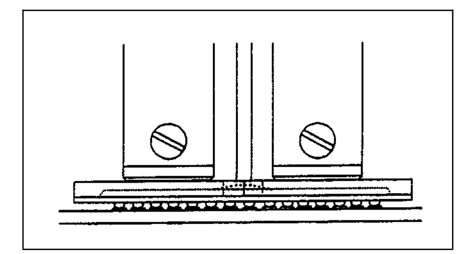


Figure 4 Melt All Joints

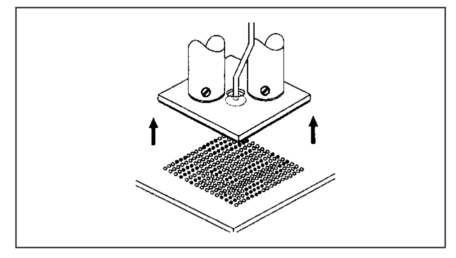


Figure 5 Lift Component

Number: **3.9.2**	Subject: **BGA Removal**
Revision: Date: 2/98	

NOTES



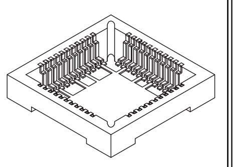
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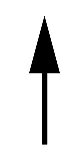
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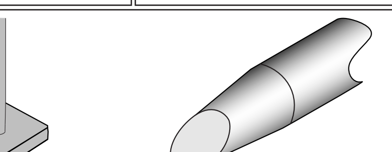
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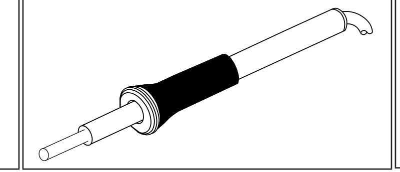
PLCC Socket Removal

Bridge Fill Method









Product Class: R, F, W, C
Skill Level: Advanced
Level of Conformance: High

EQUIPMENT REQUIRED

Soldering system
Soldering handpiece
Removal tip
Broad surface tip

MATERIALS

Flux-cored solder
Cleaner

PROCEDURE

1. Remove conformal coating (if any) and clean work area of any contamination, oxides or residues.
2. Cut tabs holding plastic center piece to PLCC socket and remove.
3. Install broad surface tip into soldering handpiece.
4. Start with tip temperature of approximately 315°C and change as necessary.
5. Using soldering handpiece, melt solder to form a solder bridge joining all component leads. (See Figure 1.)
6. Replace broad surface tip in soldering handpiece with removal tip.
7. Remove old solder from tip and thermal shock tip with damp sponge.
8. Tin the outside and bottom edges of tip with solder. (See Figure 2.)
9. Fully insert tip into component contacting ALL leads with tip. (See Figures 3 & 4.)
10. Confirm solder melt of ALL joints and lift component from PWB. (See Figures 4 & 5.)
11. Release component from tip by wiping on a heat resistant surface.
12. Re-tin tip with solder.
13. Prepare lands for component replacement.

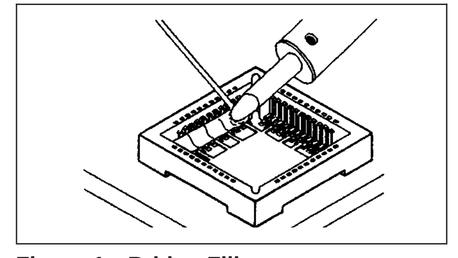


Figure 1 Bridge Fill

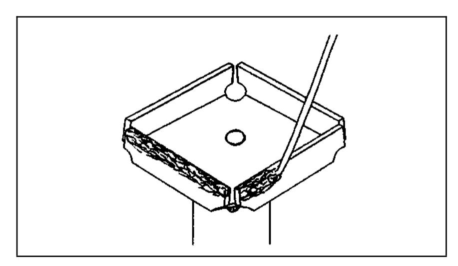


Figure 2 Tin Tips

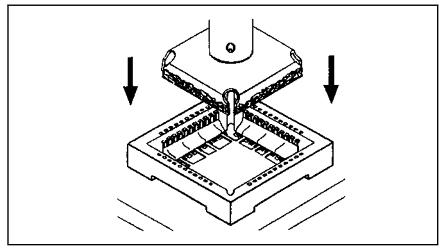


Figure 3 Position Tip

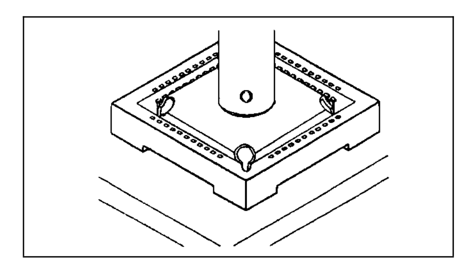


Figure 4 Melt All Joints

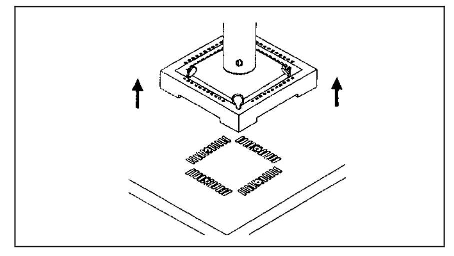


Figure 5 Lift Component

NOTES



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Rework of
Electronic Assemblies

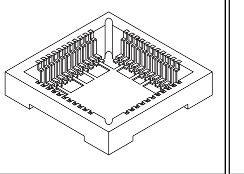
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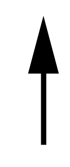
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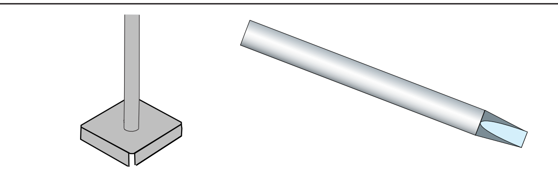
PLCC Socket Removal

Solder Wrap Method









Product Class: R, F, W, C
Skill Level: Advanced
Level of Conformance: High

EQUIPMENT REQUIRED

Soldering system
Soldering handpieces
Removal tip
Chisel tip



MATERIALS

Flux-cored solder
Cleaner

PROCEDURE

1. Remove conformal coating (if any) and clean work area of any contamination, oxides or residues.
2. Cut tabs holding plastic center piece to PLCC socket and remove.
3. Install chisel tip into soldering handpiece.
4. Start with tip temperature of approximately 315°C and change as necessary.
5. Tack solder to an inside corner lead using soldering handpiece with chisel tip installed. Wrap solder around leads inside component. Terminate solder at last lead using soldering handpiece. (See Figure 1.)
6. Replace chisel tip in soldering handpiece with removal tip.
7. Remove old solder from tip and thermal shock tip with damp sponge.
8. Tin outside and bottom edges of tip with solder. (See Figure 2.)
9. Fully insert tip into component contacting ALL leads with tip. (See Figures 3 & 4.)
10. Confirm solder melt of ALL joints and lift component from PWB. (See Figures 4 & 5.)
11. Release component from tip by wiping on a heat resistant surface.
12. Re-tin tip with solder.
13. Prepare lands for component replacement.

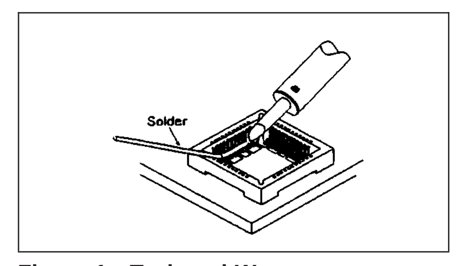


Figure 1 Tack and Wrap

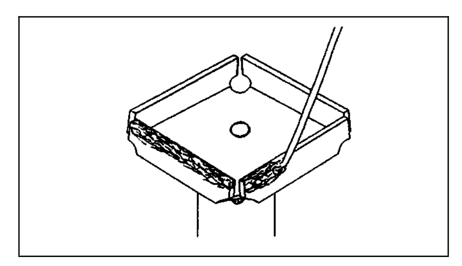


Figure 2 Tin Tip

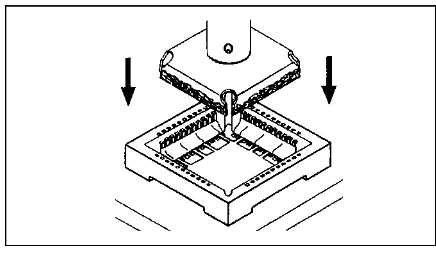


Figure 3 Position Tip

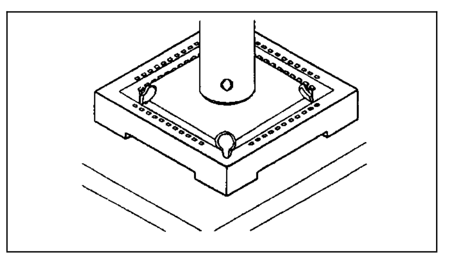


Figure 4 Melt All Joints

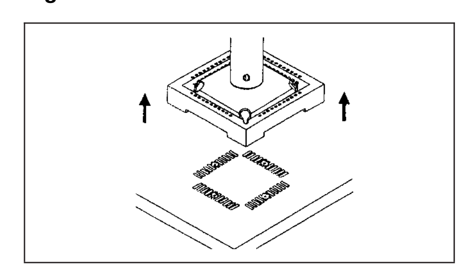


Figure 5 Lift Components

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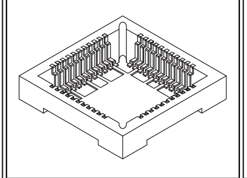
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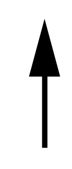
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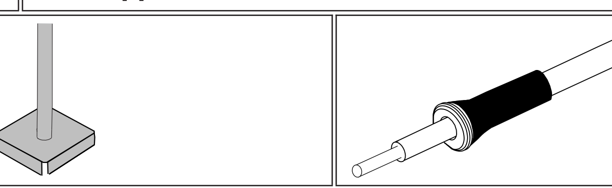
Number: **3.10.3**

PLCC Socket Removal

Flux Application Method







Product Class: R, F, W, C
Skill Level: Advanced
Level of Conformance: High

EQUIPMENT REQUIRED

Soldering system
Removal tip
Soldering handpiece

MATERIALS

Flux
Cleaner

PROCEDURE

1. Remove conformal coating (if any) and clean work area of any contamination, oxides or residues.
2. Cut tabs holding plastic center piece to PLCC socket and remove.
3. Apply flux to inside lead/land areas. (See Figure 1.)
4. Start with tip temperature of approximately 315°C and change as necessary.
5. Install removal tip into soldering handpiece.
6. Remove old solder from tip and thermal shock tip with damp sponge.
7. Tin outside and bottom edges of tip with solder. (See Figure 2.)
8. Fully insert tip into component contacting ALL leads with tip. (See Figures 3 & 4.)
9. Confirm solder melt of ALL joints and lift component from PWB. (See Figures 4 & 5.)
10. Release component from tip by wiping on a heat resistant surface.
11. Re-tin tip with solder.
12. Prepare lands for component replacement.

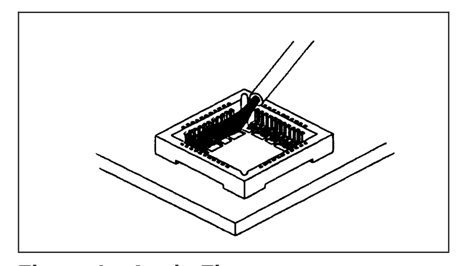


Figure 1 Apply Flux

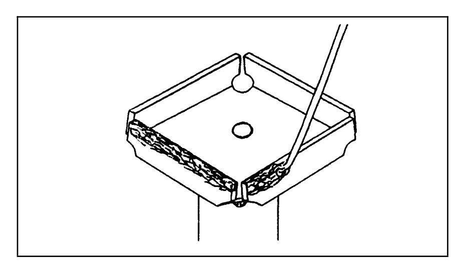


Figure 2 Tin Top

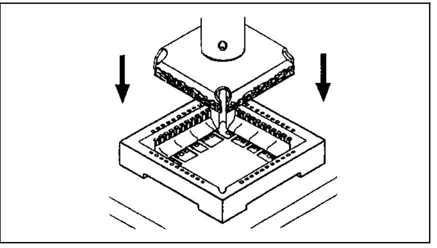


Figure 3 Position Tip

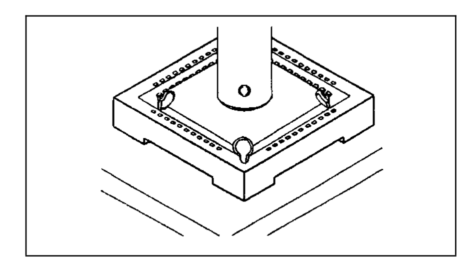


Figure 4 Melt All Joints

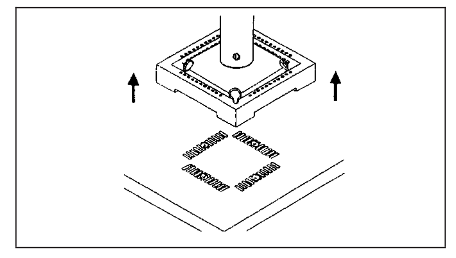


Figure 5 Lift Component

Number: **3.10.3**	Subject: **PLCC Socket Removal**
Revision: Date: 2/98	

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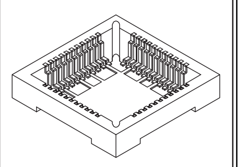
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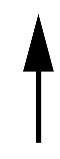
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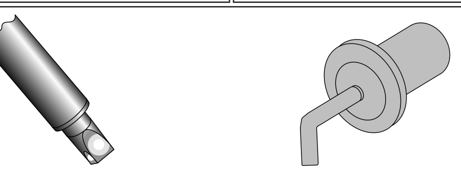
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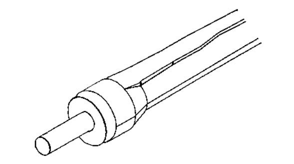
PLCC Socket Removal

Hot Air Pencil Method









Product Class:
Skill Level: Advanced
Level of Conformance: Medium

EQUIPMENT REQUIRED

Hot air pencil
Hot air tip
Needle nose pliers
Knife

OPTIONAL EQUIPMENT

Desoldering station

MATERIALS

Flux-cored solder
Flux
Cleaning solvent

PROCEDURE

1. Remove conformal coating (if any) and clean work area of any contamination, oxides or residues.
2. Cut and remove plastic center. (See Figure 1.)
3. Install appropriate hot air tip into the hot air pencil.
4. Set heater temperature to approximately 425°C and adjust as necessary.
5. Adjust pressure output so hot air scorches a tissue from approximately 0.5 cm away.
6. Position tip approximately 0.5 cm away from inside area of socket. Rotate hot air pencil in a circular motion around lands until complete solder melt is observed. (See Figure 2.)
7. Approximately 5 to 8 seconds after solder melt occurs, begin lifting the socket very gently and only a little at a time until the socket becomes detached. (See Figure 3.) This entire step should take approximately 45 seconds.
8. After solder melt occurs, clean and inspect as required.

CAUTION: This method is not recommended unless there are no other options. PWB will be subjected to excessive heat.

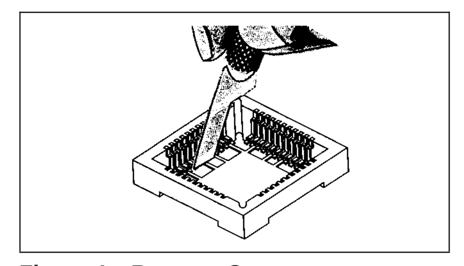


Figure 1 Remove Center

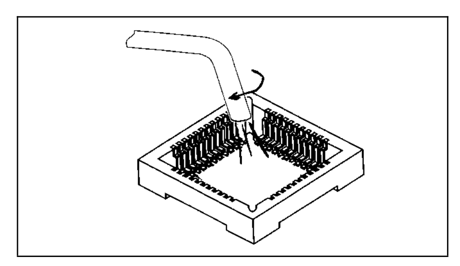


Figure 2 Melt Solder

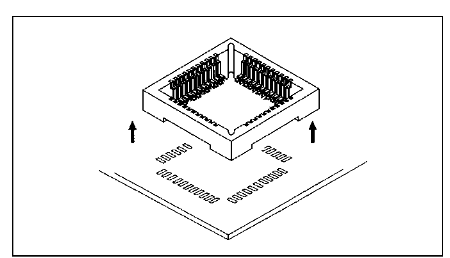
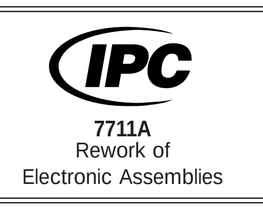


Figure 3 Lift Socket

Number: **3.10.4**	Subject: **PLCC Socket Removal**
Revision: Date: 2/98	

NOTES



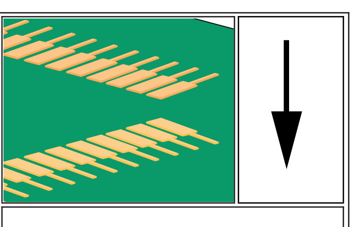
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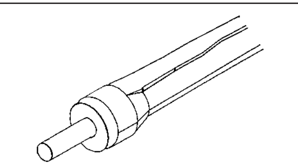
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Date: 2/98

Number: 4.1.1

Surface Mount Land Preparation

Individual Method





Product Class: R, F, W, C
Skill Level: Intermediate
Level of Conformance: High

EQUIPMENT REQUIRED

Continuous vacuum desoldering system
Desoldering tip

MATERIALS

Flux
Cleaner
Tissue/wipes

PROCEDURE

1. Remove conformal coating (if any) and clean work area of any contamination, oxides, residues or fluxes.
2. Install desoldering tip into handpiece.
3. Start with tip temperature of approximately 315°C and change as necessary.
4. Apply flux to all land areas. (See Figure 1.)
5. Lower tip contacting end of land(s) with tip. (See Figure 2.)
6. Confirm solder melt of contacted land(s), apply vacuum and sweep tip over land holding tip in contact with solder to extract excess solder from PWB land(s). (See Figure 3.)
7. Lift tip at end of last row, hold vacuum to clear all molten solder from the heater chamber. (See Figure 4.)
8. Repeat for all lands.
9. Return handpiece to its stand.
10. Clean lands as required for component replacement.

NOTE

The individual method is the method of choice for fine pitch land patterns.

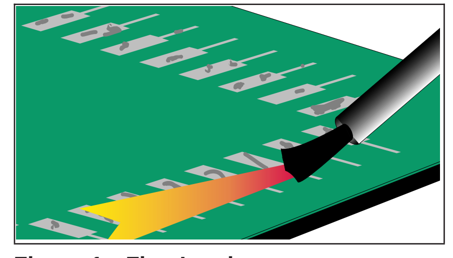


Figure 1 Flux Lands

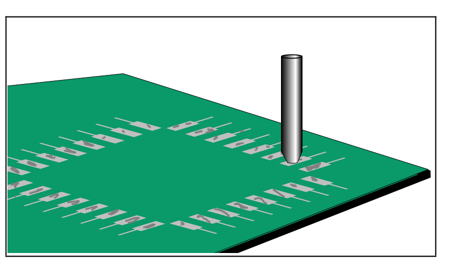


Figure 2 Position Tip

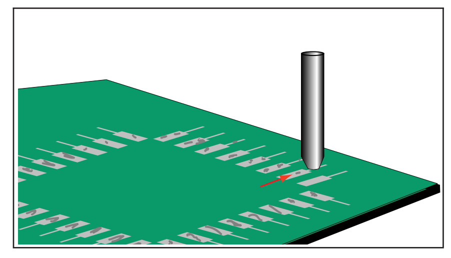


Figure 3 Melt Solder & Apply Vacuum

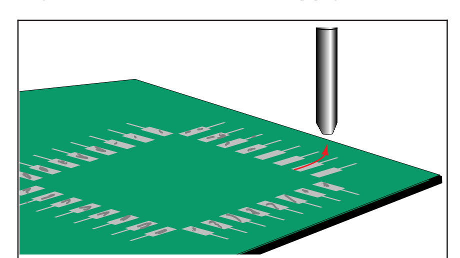
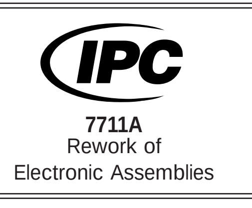


Figure 4 Lift Handpiece

NOTES



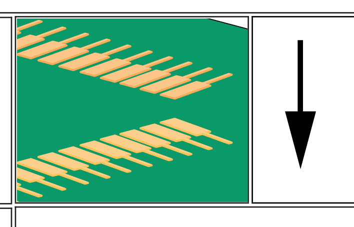
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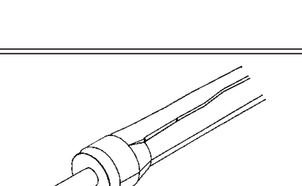
Revision:
Date: 2/98

Number: **4.1.2**

Surface Mount Land Preparation

Continuous Method





Product Class: R, F, W, C
Skill Level: Intermediate
Level of Conformance: High

EQUIPMENT REQUIRED

Continuous vacuum desoldering system
Desoldering tip
Damp sponge

MATERIALS

Flux-cored solder
Flux
Cleaner
Tissue/wipes

PROCEDURE

1. Remove conformal coating (if any) and clean work area of any contamination, oxides, residues or fluxes.
2. Install appropriate desoldering tip into handpiece.
3. Start with tip temperature of approximately 315°C and change as necessary.
4. Apply flux to all land areas. (See Figure 1.)
5. Thermal shock tip with damp sponge.
6. Tin bottom of tip with solder. (See Figure 2.)
7. Lower tip contacting end of row lands with tip. (See Figure 3.)
8. Confirm solder melt of contacted lands, apply vacuum and sweep tip over remaining lands in all rows holding tip in contact with solder to extract excess solder from PWB lands. (See Figure 4.)
9. Lift tip at end of last row, hold vacuum to clear all molten solder from the heater chamber. (See Figure 5.)
10. Re-tin tip end with solder and return handpiece to its stand.
11. Clean lands as required for component replacement.

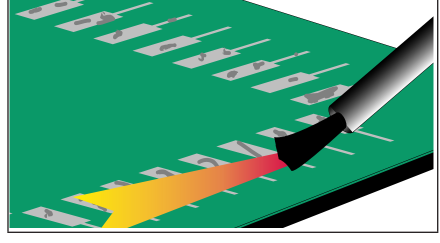


Figure 1 Flux Lands

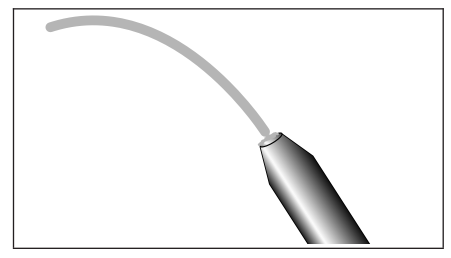


Figure 2 Tin Tip

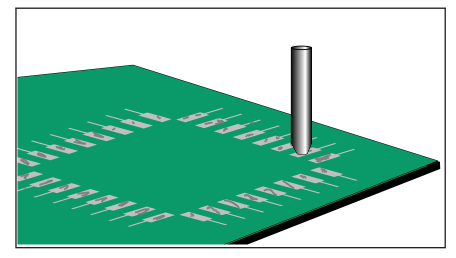


Figure 3 Position Tip

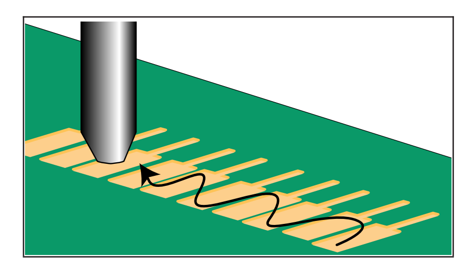


Figure 4 Melt Solder & Apply Vacuum

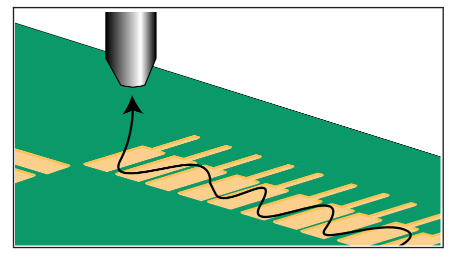
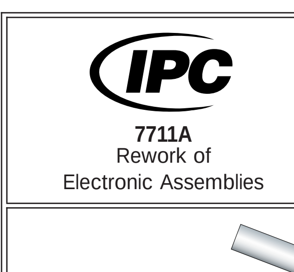


Figure 5 Lift Hand Piece

Number: **4.1.2**	Subject: **Surface Mount Land Preparation**
Revision: Date: 2/98	

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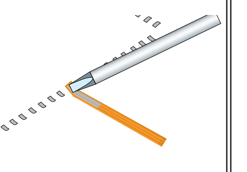
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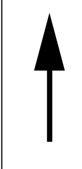
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Date: 2/98

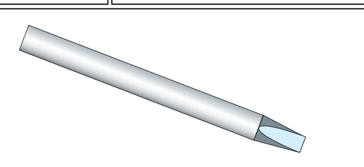
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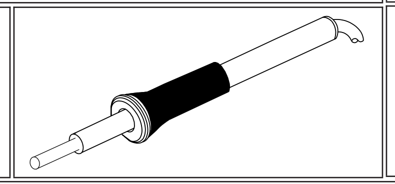
Surface Solder Removal

Braid Method









Product Class: R, F, W, C
Skill Level: Intermediate
Level of Conformance: High

EQUIPMENT REQUIRED

Soldering system
Soldering handpiece
Chisel tip
Damp sponge

MATERIALS

Wicking braid
Flux
Cleaner

PROCEDURE

Caution: The wicking method is not recommended for the removal of solder joints in plated-through holes.

1. Remove conformal coating (if any) and clean work area of any contamination, oxides or residues.
2. Install chisel tip into soldering handpiece.
3. Start with tip temperature of approximately 315°C and change as necessary.
4. Apply flux to lead/land areas. (See Figure 1.)
5. Remove old solder from tip and thermal shock tip with damp sponge. (See Figure 2.)
6. Place prefluxed braid on the solder to be removed. Place iron tip on the braid. Ensure the braid contacts only the solder and the tip contacts only the braid to prevent damage. (See Figure 3.)
7. When the observable solder flow due to solder wicking action has ceased, remove both the soldering iron and solder braid from the solder being removed and allow the area to cool to room temperature. (See Figures 4 & 5.)
8. Repeat steps 4 - 7 for all remaining lead/land areas.
9. Re-tin tip with solder and return handpiece to stand.
10. Prepare lands for component replacement.

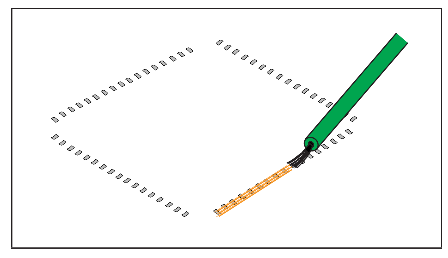


Figure 1 Apply Flux

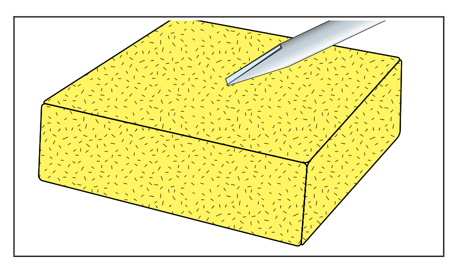


Figure 2 Clean Tip

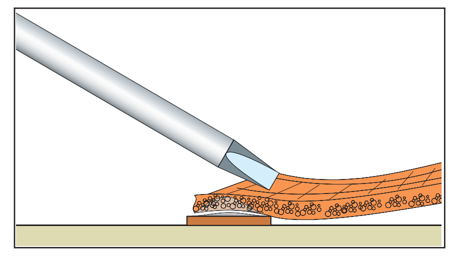


Figure 3 Place Braid & Iron on Land

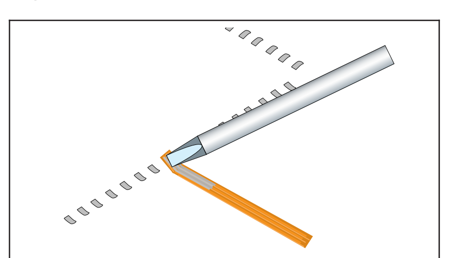


Figure 4 Solder Flows on Braid

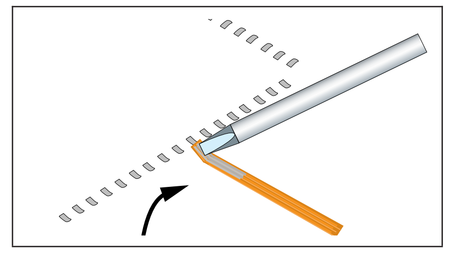
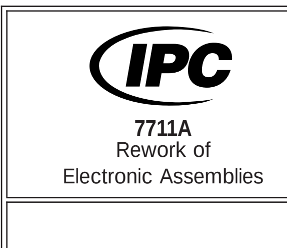


Figure 5 Lift Both Iron & Braid

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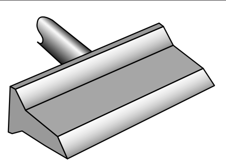
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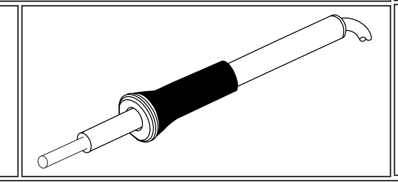
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Number: **4.2.1**

Pad Releveling

Using Blade Tip





Product Class: R, F, W, C
Skill Level: Intermediate
Level of Conformance: High

EQUIPMENT REQUIRED

Soldering system(s)
1 or 2 Soldering handpieces
Dual or single shaft blade tip

MATERIALS

Flux

PROCEDURE

This technique can be used in cases where components have been removed in such a manner that sufficient solder to tin the lands is left on the lands after removal of the component. This is almost always the case when hot air or wire wrap methods are used in the removal.

1. Choose a blade tip with a width that matches or slightly overhangs a single row of lands. (See Figure 1.)
2. Install tip.
3. Start with the coolest tip temperature possible (approximately 280°C) and change as necessary.
4. Tin and wipe the blade on a clean sponge to ensure that the surface is clean and fully wettable.
5. Apply flux to the row of lands.
6. Place the beveled edge lightly across the center of the row of lands. (See Figure 2.)
7. When the solder reflows across all the lands they will become uniform and shiny.
8. Draw the tip evenly off the lands as soon as possible after all the lands become shiny and uniform in appearance.* (See Figure 3.)

* *Note:* This technique reuses solder that is in indeterminate condition.

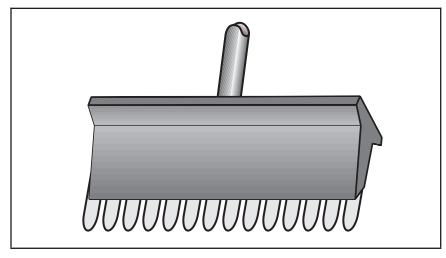


Figure 1 Blade Fits Lands

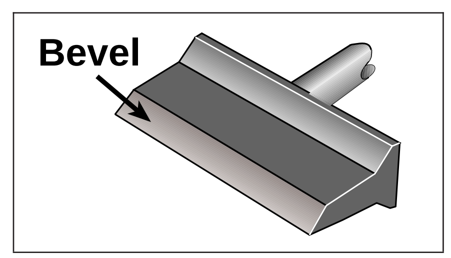


Figure 2 Use Beveled Edge

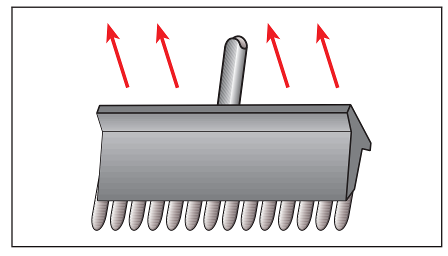
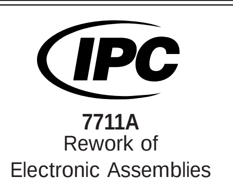


Figure 3 Draw Tip Off Evenly

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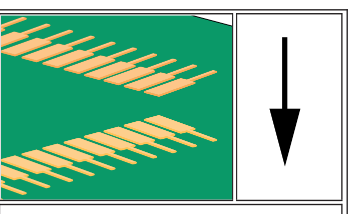
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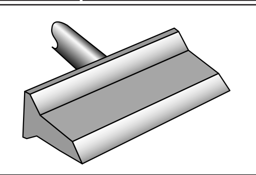
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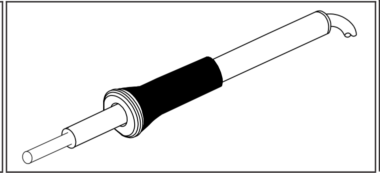
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SMT Land Tinning

Using Blade Tip







Product Class: R, F, W, C
Skill Level: Intermediate
Level of Conformance: Medium

EQUIPMENT REQUIRED

Soldering system(s)
1 or 2 Soldering handpieces
Dual or single shaft blade tip

MATERIALS

Flux-cored solder
Flux

PROCEDURE

1. Choose a blade tip with a width that matches or slightly overhangs a single row of pads. (See Figure 1.)
2. Install tip.
3. Start with the coolest tip temperature possible (approximately 280°C) and change as necessary.
4. Tin and wipe the blade on a clean sponge to ensure that the surface is clean and fully wettable.
5. Apply flux to the row of lands.
6. Place an even bead of solder along the full length of the beveled edge. (See Figure 2.)
7. Place the beveled edge lightly across the center line of the row of lands. (See Figure 3.)
8. When the solder reflows across all the lands they will become uniform and shiny.
9. Gently draw the tip off the lands as soon as the lands are tinned. (See Figure 4.)

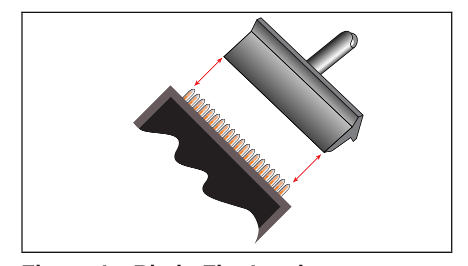


Figure 1 Blade Fits Lands

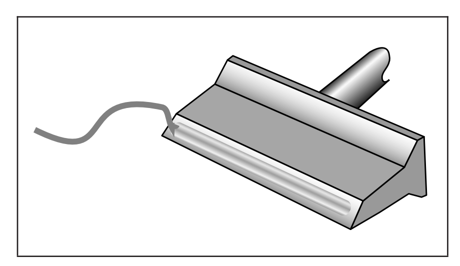


Figure 2 Tin Tip

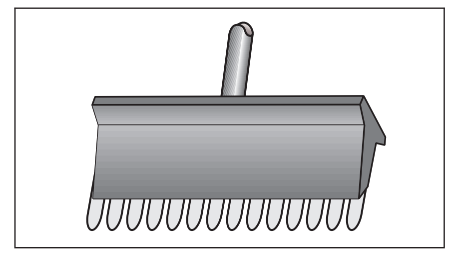


Figure 3 Place Beveled Edge Across

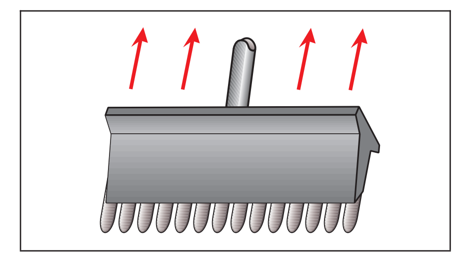


Figure 4 Draw Tip Off Lands

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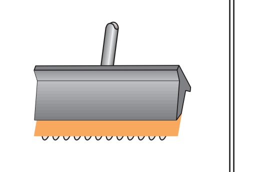
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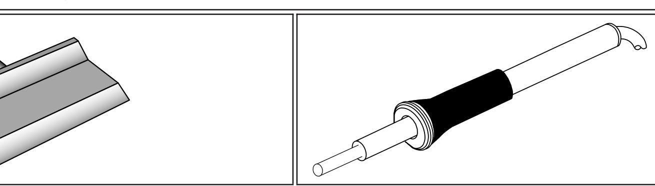
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Number: 4.4.1

Cleaning SMT Lands

Using Blade Tip and Solder Braid





Product Class: R, F, W, C
Skill Level: Intermediate
Level of Conformance: High

EQUIPMENT REQUIRED

Soldering Systems(s)
1 or 2 Soldering handpieces
Single or dual shaft blade tip

MATERIALS

Solder braid
Flux
Cleaner

PROCEDURE

This technique uses a blade tip with solder braid to draw old solder off the lands. The blade tip used should be as long or a little longer than the row of lands. The braid should also be sized to the lands, so that the braid width equals or is slightly less than the land length.



CAUTION

Oversized braids are not to be used. Undersized braids may be drawn across the surface of the land, but only with the grain of the land. Never draw solder off by dragging the braid down a row of lands. The heat combined with the abrasive action will lift the lands.

1. Choose the size of blade tip that best fits a single row of lands. (See Figure 1.)
2. Install tip.
3. Start with tip temperature of approximately 371°C and change as necessary.
4. Apply flux to the lands. (See Figure 2.)
5. Lay the trimmed end of the braid along the row of lands to be cleaned. (See Figure 3.)
6. Bring the beveled edge of the blade down on the centerline of the braid. Do not move the braid across the lands in any direction. (See Figure 4.)
7. Remove braid and tip together, immediately after reflow.
8. Clean the flux residue from the lands.

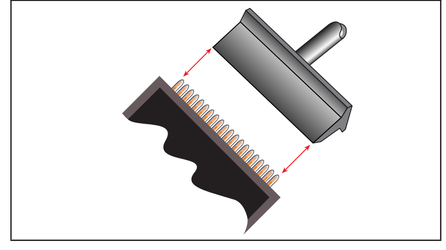


Figure 1 Choose Tip

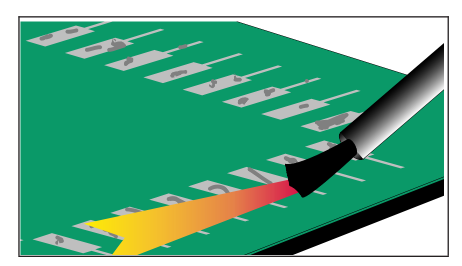


Figure 2 Apply Flux

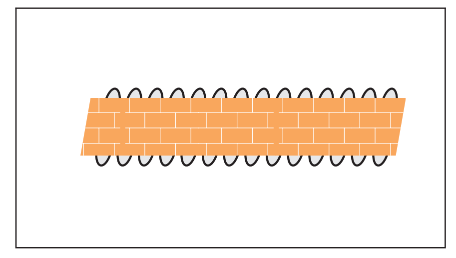


Figure 3

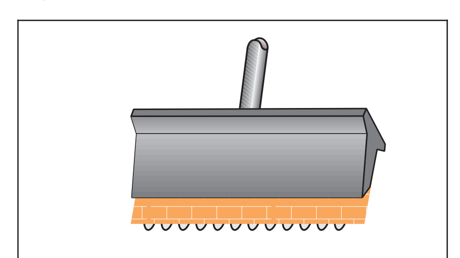


Figure 4

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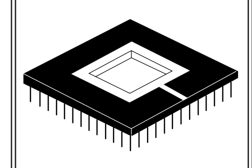
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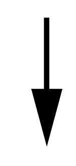
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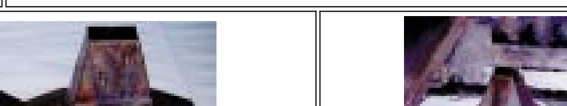
Number: **5.2.1**

PGA and Connector Installation

Solder Fountain Method with PTH Prefilled









Product Class: R, F, W, C
Skill Level: Expert
Level of Conformance: Medium

EQUIPMENT REQUIRED

Solder fountain
Chimney or nozzle to match part
Removal tool
Pallet to hold board over fountain
Preheat oven

MATERIALS

Flux
Cleaner
Heat resistant, antistatic gloves
Protective face gear
Heat resistant tape

PROCEDURE

This procedure variation is for components or connectors with sturdy leads that do not readily bend.

This process is for experienced operators only. Caution must be exercised due to working with hot, molten solder.

1. Attach the correct nozzle or chimney to the solder pot. This operation must be done with proper care per solder fountain supplier's instructions. (See Figure 1.)
2. Set solder fountain pot control to the required temperature for soldering that particular component into that particular board. Wait until solder pot reaches the set temperature.
3. Set the timer (if applicable) for the amount of time the fountain is to be running for that particular part.
4. The area around the rework site may be masked with a high temperature resistant tape, or similar material, to protect the adjacent area during rework. (See Figure 2.)
5. Preheat the new component and the board to the desired temperature, taking into consideration component thermal restrictions and glass transition temperature T_g of the board material.
6. Flux the board on the top and bottom side at the site of the new component. The component leads may also be fluxed, depending on the board and component leads. Place the component on the board in its correct site. (See Figure 2.)
7. Place the board on the pallet, over the solder fountain with the component sitting in location and trip the solder fountain timer. (See Figure 3.)
8. As the solder in the holes reflows, the component may have to be reoriented to drop into the holes.

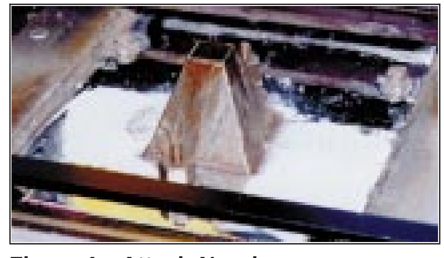


Figure 1 Attach Nozzle

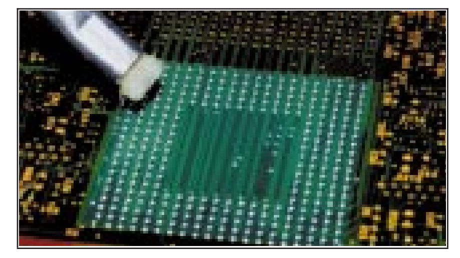


Figure 2 Flux

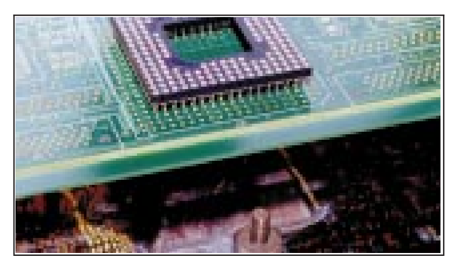


Figure 3 Place Over Solder Fountain

9. At the end of the timer cycle, wait at least 5 seconds for the solder to solidify, then remove the board.
10. Clean the flux residue, if required, and inspect.

NOTES



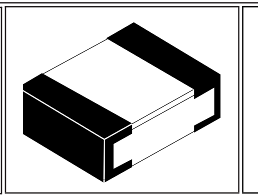
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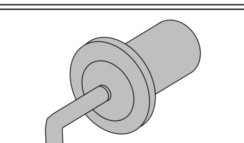
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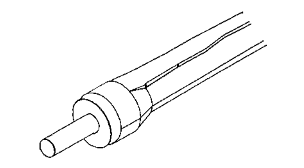
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Chip Installation

Solder Paste Method/Hot air Pencil







Product Class: R, F, C, W
Skill Level: Intermediate
Level of Conformance: High

EQUIPMENT REQUIRED

Hot air pencil
Hot air tip
Solder paste dispenser
Tweezers

MATERIALS

Solder paste
Cleaner
Solder paste dispense needles
Tissue/wipe

PROCEDURE

NOTE: Preheating is recommended for sensitive components. (i.e., chip capacitors.)

1. Install tip into hot air pencil.
2. Start with tip temperature of approximately 315°C and change as necessary.
3. Adjust pressure output so hot air scorches a tissue from approximately 0.5 cm away. (See Figure 3.)
4. Apply a small bead of solder paste to each land using a dispenser. (See Figure 1.)
5. Position component onto lands using tweezers. (See Figure 2.)
6. Direct hot air over component with tip at a distance of 2.5 cm to pre-dry solder paste. (See Figure 4.)
7. When pre-drying is observed (paste has dull, flat appearance), move tip closer (0.5 cm) and heat until complete solder melt is observed. (See Figure 5.)
8. Return hot air pencil to its stand.
9. Clean, if required, and inspect.

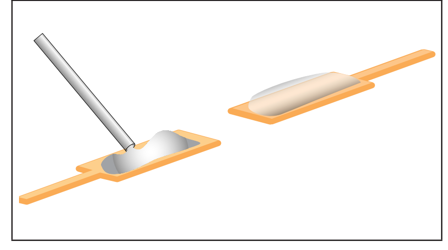


Figure 1 Apply Solder Paste

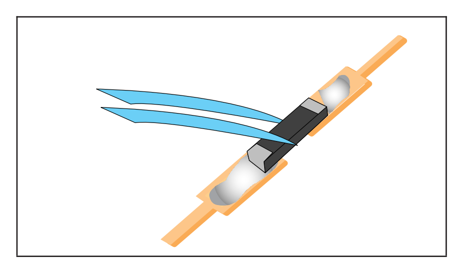


Figure 2 Position Component

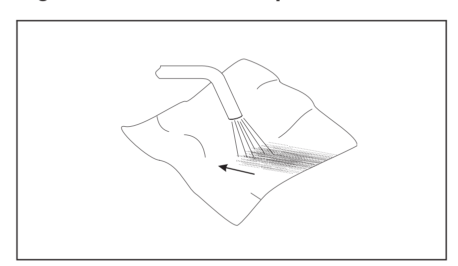


Figure 3 Adjust Pressure

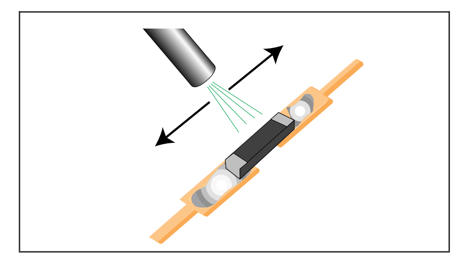


Figure 4 Pre-dry Paste

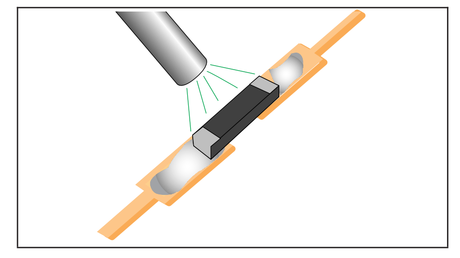


Figure 5 Melt Joints

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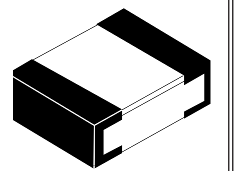
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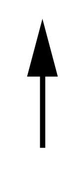
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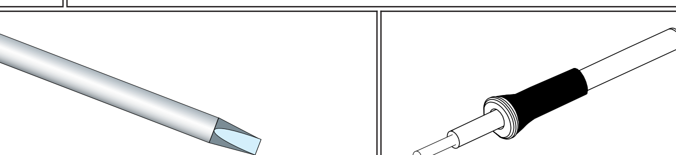
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Chip Installation

Point to Point Method







Product Class: R, F, W, C
Skill Level: Intermediate
Level of Conformance: High

EQUIPMENT REQUIRED

Soldering iron
Chisel or conical tip
Damp sponge
Wood stick or tweezers

MATERIALS

Flux-cored solder
Flux
Cleaner
Tissue/wipes

NOTE

Preheating is recommended for sensitive components (i.e., chip capacitors).

PROCEDURE

1. Remove conformal coating (if any) and clean work area of any contamination, oxides, residues or fluxes.
2. Install soldering iron tip in handpiece.
3. Start with tip temperature of approximately 315°C and change as necessary.
4. Apply flux to one land (optional).
5. Thermal shock tip with damp sponge.
6. Prefill one land with solder. (See Figure 1.)
7. Place the component in position and hold it with a wooden stick or tweezers.
8. Apply flux to both lands.
9. Place the tip at the junction between the prefilled land and termination area of component.
10. Observe complete solder melt. This is evident by component dropping down onto land. area. (See Figure 2.)
11. Pause briefly for solder to solidify
12. Solder remaining side by applying additional solder as needed. (See Figure 3.)
13. Re-tin tip end with solder and return handpiece to its stand.
14. Clean lands as required for component replacement.

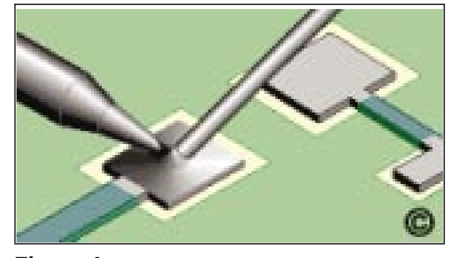


Figure 1

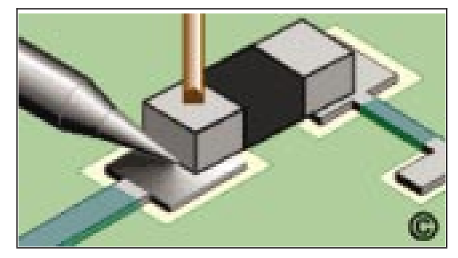


Figure 2

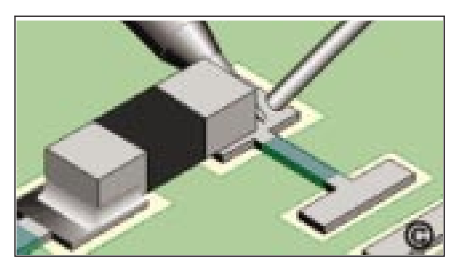
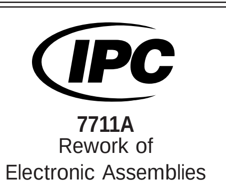


Figure 3

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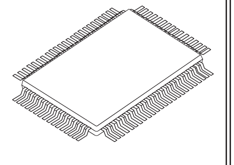
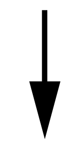
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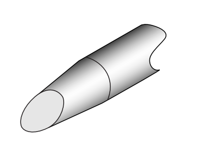
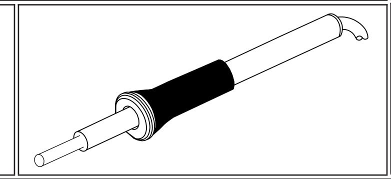
Revision: **A**
Date: 5/02

Number: **5.5.1**

Gull Wing Installation

Multi-Lead Method – Top of Lead

Product Class: R, F, W, C
Skill Level: Advanced
Level of Conformance: High

EQUIPMENT REQUIRED

Soldering system
Flat faced or cup-shaped tip
Damp sponge
Vacuum pick-up tool

OPTIONAL EQUIPMENT

Tweezers

MATERIALS

Flux-cored solder
Flux
Cleaner

PROCEDURE

1. Install selected tip into the soldering handpiece.
2. Start with tip temperature of approximately 315°C and change as necessary.
3. Position the component ensuring proper lead-to-land alignment. Hold the component in place using the vacuum pick-up tool or tweezers. (See Figure 1.)
4. Apply flux and tack solder opposing corner leads. (See Figure 2.)
5. Apply flux to remaining lead/land areas. (See Figure 3.)
6. Clean tip using a damp sponge.
7. Apply solder to tip to create a bead of molten solder. (See Figure 4.)
8. Position tip so the solder bead contacts the top portion of leads. Slowly move tip over the row of leads to form proper solder fillets at each joint. (See Figure 5.)
9. Repeat steps 7 through 8 on remaining sides of component.
10. Re-tin tip with solder.
11. Clean, if required, and inspect.

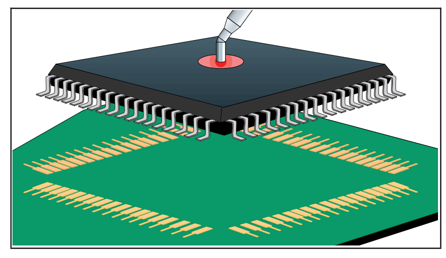


Figure 1 Position Component

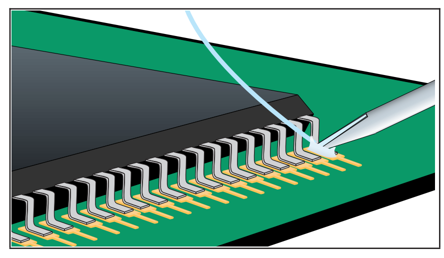


Figure 2 Tack Lead

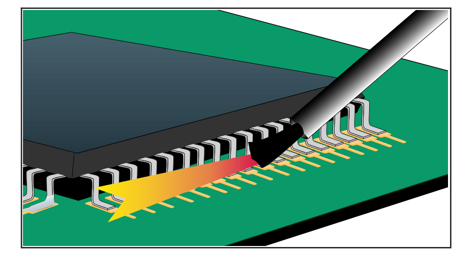


Figure 3 Flux Leads

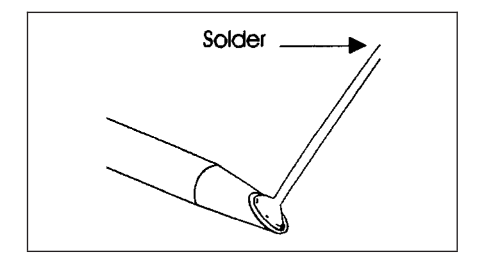


Figure 4 Fill Tip

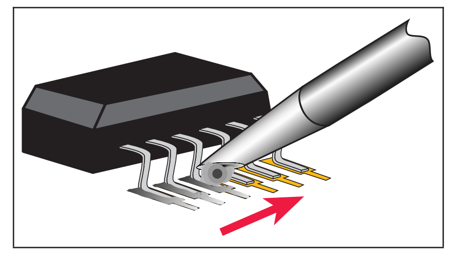


Figure 5 Solder Component

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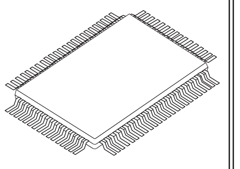
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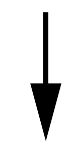
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Date: 2/98

Number: **5.5.2**

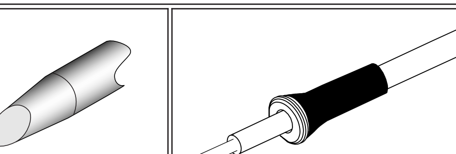
Gull Wing Installation

Multi-Lead Method – Toe Tip









Product Class: R, F, W, C
Skill Level: Advanced
Level of Conformance: High

EQUIPMENT REQUIRED

Soldering system
Flat faced or cup-shaped tip

MATERIALS

Flux
Flux-cored solder

NOTE

This technique is most effective with very fine pitch components. Long leads may not be able to get enough solder to the heel to form a proper fillet without overheating the land. This procedure is recommended for temperature sensitive components.

PROCEDURE

1. Install selected tip into the soldering handpiece.
2. Start with tip temperature of approximately 315°C and change as necessary.
3. Align the component carefully to the lands. (See Figure 1.)
4. Flux and tack the leads at opposing corners to fix the component to the board. (See Figure 2.)
5. Wipe the excess solder from the tip and make sure that the face of the tip is shiny and wettable.
6. Apply enough solder to cover approximately one-third of the tip. The amount of solder will vary with the number and pitch of the leads. For fewer leads, or finer pitch leads, apply less solder. Place the solder at the edge of the tip face that will meet the leads, rather than directly at the tip. (See Figure 3.)
7. Flux the first row of leads to be soldered. Start the soldering process with a row that has not been tacked, or from the opposite end of the row from the tack if the component only has two rows of leads.
8. Bring the tip down at an angle to the point where the toe of the lead meets the land, so that the edge with solder on it is on the land, but the face is tilted away from the component. The side of the tip will be in contact with the lead. (See Figure 4.)
9. Hold the tip so the shaft runs parallel to the row of leads, that is, with the side of the tip toward the side of the component. The angle between the side of the tip and the side of the component would ideally be zero for maximized heat transfer, but can be up to 30° depending on operator preference. (See Figure 5.)
10. Immediately begin running the tip down the toes of the leads. Do not apply pressure to the leads.
11. Repeat steps 5 through 10 for each row of leads.

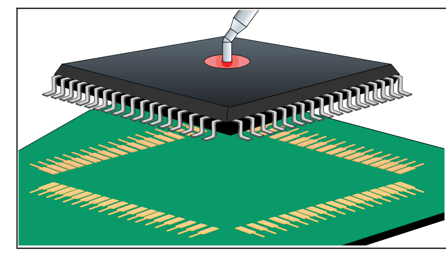


Figure 1 Align Component

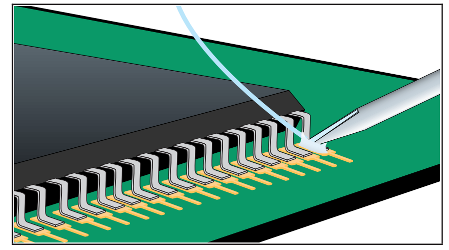


Figure 2 Flux & Tack 2 Corner Leads

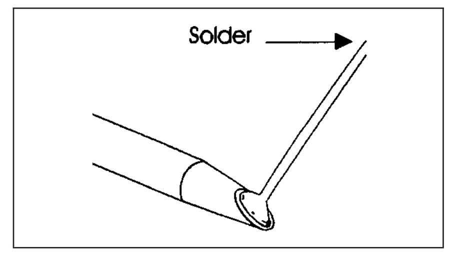


Figure 3 Apply Solder to 1/3 Tip

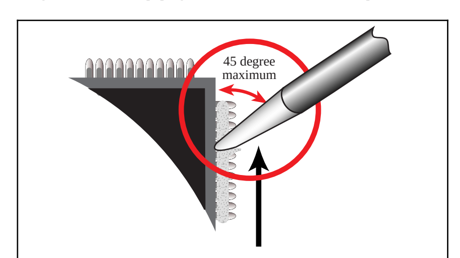


Figure 4 45° or Less

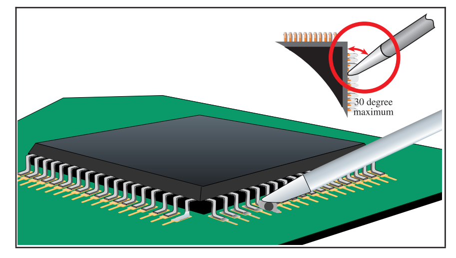


Figure 5 Draw Tip Side Down Toes

Number: **5.5.2**	Subject: **Gull Wing Installation**
Revision: Date: 2/98	

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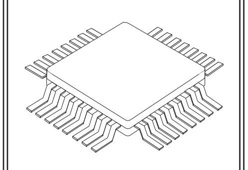
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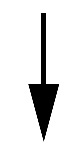
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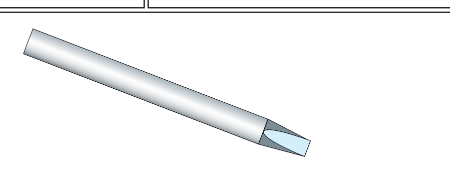
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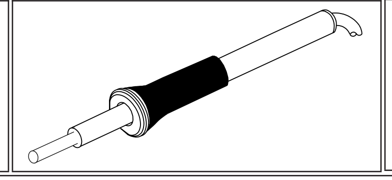
Gull Wing Installation

Point-to-Point Method









Product Class: R, F, W, C
Skill Level: Intermediate
Level of Conformance: High

QUIPMENT REQUIRED

Soldering system
Chisel tip
Vacuum pick-up tool

OPTIONAL EQUIPMENT

Tweezers

MATERIALS

Flux-cored solder
Flux
Cleaner

PROCEDURE

1. Install chisel tip into soldering handpiece.
2. Start with temperature of approximately 315°C and change as necessary.
3. Position component ensuring proper lead-to-land alignment. Hold component in place using the vacuum pick up tool or tweezers. (See Figure 1.)
4. Apply flux and tack solder opposing corner leads. (See Figure 2.)
5. Apply flux to remaining lead/land areas of the row to be soldered. (See Figure 3.)
6. Clean tip using a damp sponge. (See Figure 4.)
7. Position chisel tip on lead. Apply solder to side of lead/land area to form proper solder fillet. (See Figure 5.)
8. Repeat step 7 on remaining leads of component.
9. Re-tin chisel tip with solder.
10. Clean, if required, and inspect.

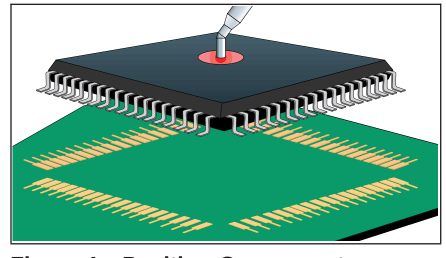


Figure 1 Position Component

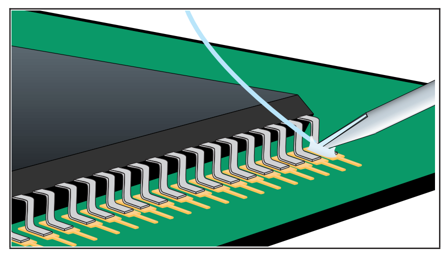


Figure 2 Tack Lead

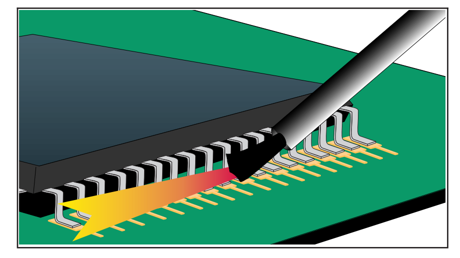


Figure 3 Apply Flux

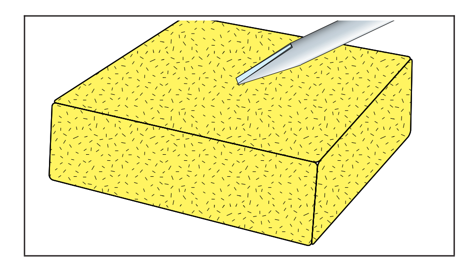


Figure 4 Clean Tip

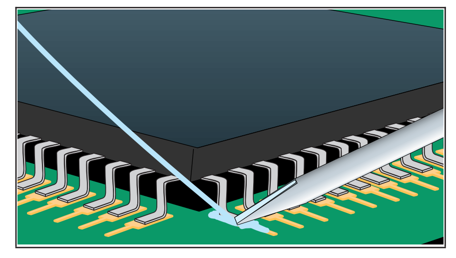


Figure 5 Solder Leads

Number: **5.5.3**	Subject: **Gull Wing Installation**
Revision: Date: 2/98	

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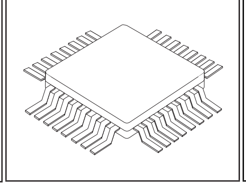
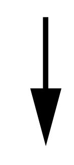
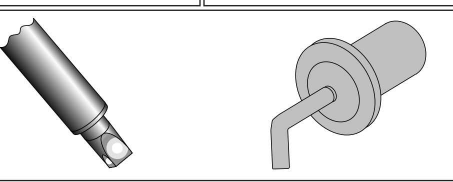
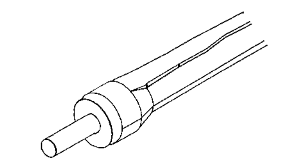


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Revision:
Date: 2/98
Number: **5.5.4**

Gull Wing Installation

Hot Air Pencil/Solder Paste Method

Product Class: R, F, W, C
Skill Level: Advanced
Level of Conformance: High

EQUIPMENT NEEDED

Hot air pencil
Hot air tip
Liquid dispensing system
Tweezers
Vacuum pick-up tool

OPTIONAL EQUIPMENT

Manual solder paste dispenser

MATERIALS

Solder paste
Cleaner
Solder paste dispense needles
Tissue/wipe

PROCEDURE

1. Install tip into hot air pencil.
2. Set heater temperature of approximately 425°C and change as necessary.
3. Apply a small bead of solder paste along the land pattern using a dispenser. (See Figure 1.)
4. Position component onto lands using a vacuum pick up tool or tweezers. (See Figure 2.)
5. Adjust pressure output so hot air scorches a tissue from approximately 0.5 cm away. (See Figure 3.)
6. Direct hot air over component with tip at a distance of 2.5 cm to pre-dry solder paste. (See Figure 4.)
7. When pre-drying is observed (paste has dull, flat appearance), move tip closer (0.5 cm) and heat until complete solder melt is observed. (See Figure 5.)
8. Clean, if required, and inspect.

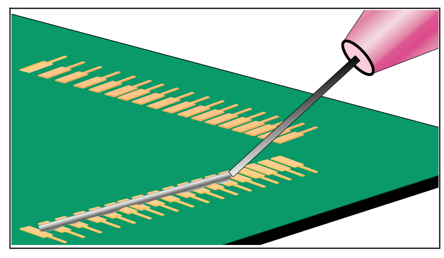


Figure 1 Apply Solder Paste

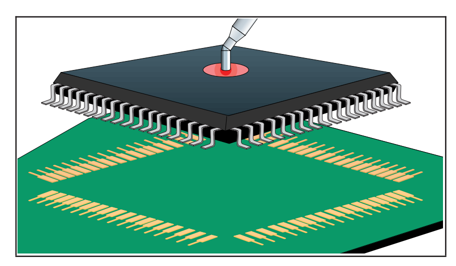


Figure 2 Position Component

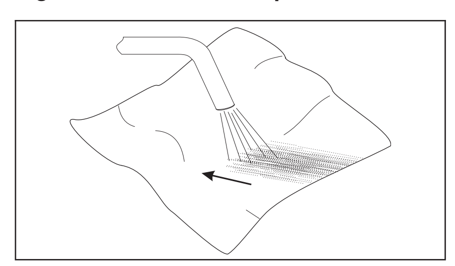


Figure 3 Adjust Pressure

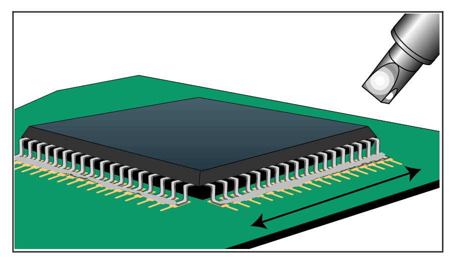


Figure 4 Pre-dry Paste

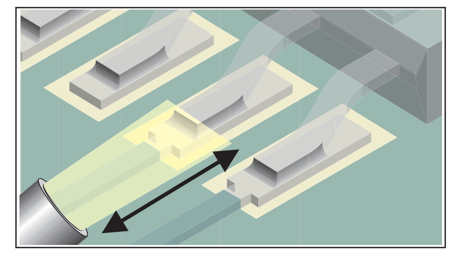
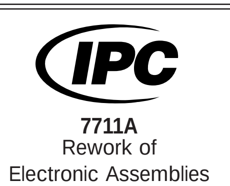


Figure 5 Melt Joints

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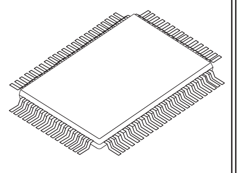
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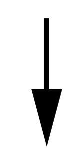
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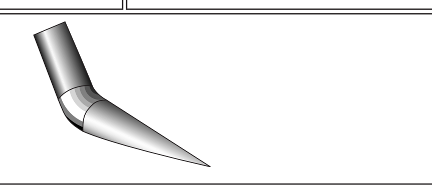
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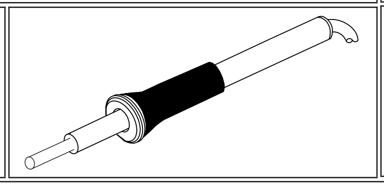
Gull Wing Installation

Hook Tip w/Wire Layover









Product Class: R, F, W, C
Skill Level: Intermediate
Level of Conformance: High

EQUIPMENT REQUIRED

Soldering system
Soldering handpiece
Hook tip

MATERIALS

Solder form wire recommended less than 0.4 mm
Flux-cored solder
Flux

NOTES

The type of vision assistance will vary with the pitch of the components to be soldered and should be determined by the needs of each assembly and/or operator.

The amount of flux necessary is minimal.

PROCEDURE

1. Install tip into handpiece.
2. Start with tip temperature of approximately 315°C and change as necessary.
3. Begin by applying flux to a corner land, then place a light bump of solder evenly across the land. This will be the first of two points that will fix the component to the board. (See Figure 1.)
4. Align the component to the lands. Since one lead will be resting on a solder bump, do not expect proper coplanarity at this point.
5. When the component is properly aligned, lightly flux the prepped land and the lead over it and bring a clean tip down to the land, in front of the toe of the lead. Do not contact the lead – heat only the land. (See Figure 2.)
6. Clean tip with damp sponge.
7. Move to the diagonally opposite corner lead from the one that was just tacked. Reposition the component if the alignment has wandered, and lightly flux the lead. Place a lightly tinned tip on the land in front of the lead, allow it to absorb heat for a moment, then feed solder wire to the land at the gap between the tip and the lead to create the second fixturing joint (See Figure 3.)
8. Lightly flux the first row of leads to be soldered. (See Figure 4.)
9. Lay the solder wire along the inside of the curve that forms the lead's heel.
10. Tin the tip lightly to create a solder bridge that will facilitate heat transfer.
11. Skipping the tacked leads, move down the row, placing the tip on each land consecutively, abutting the toe of lead. When the joint is properly formed, move to the next lead until the row is completed. (See Figure 5.)

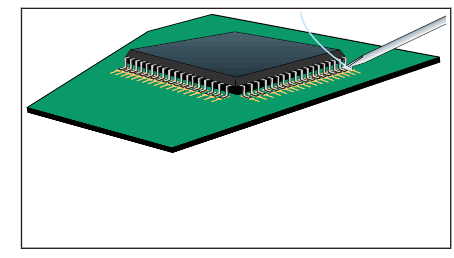


Figure 1 Start at Corners

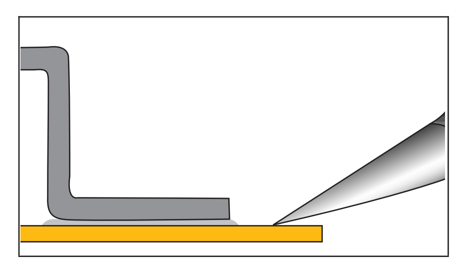


Figure 2 Heat Only Land

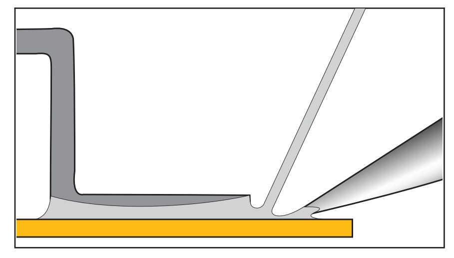


Figure 3 Feed Solder into Gap

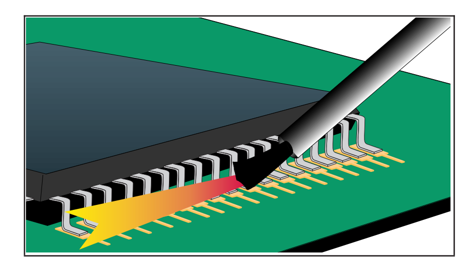


Figure 4 Flux Leads

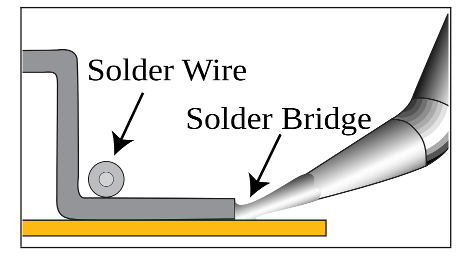


Figure 5 Align Tip Lead

12. Repeat steps 6 through 9 on each row.
13. Clean, if required, and inspect.

NOTES



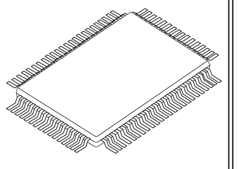
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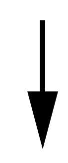
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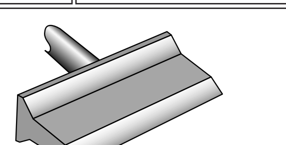
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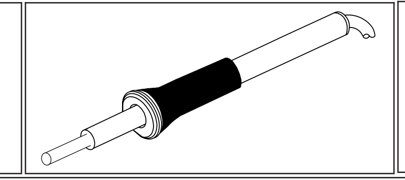
Gull Wing Installation

Blade Tip with Wire









Product Class: R, F, W, C
Skill Level: Advanced
Level of Conformance: Medium

EQUIPMENT REQUIRED

Soldering system(s)
1 or 2 Soldering handpieces
Blade tip

MATERIALS

Flux-cored solder
Flux

PROCEDURE

1. Select a blade tip appropriate for the component being soldered and the clearances available on the board. The tip should allow each row to be soldered in one pass. (See Figure 1.)
2. Start with tip temperature of approximately 315°C and change as necessary.
3. Tin the tip on the beveled edge and clean the surface on the sponge. If this does not produce a clean shiny surface use the manufacturer's recommended methods to remove any oxidation and/or discoloration. (See Figure 2.)
4. Flux the row to be soldered. (See Figure 3.)
5. Place wire solder across the row of leads at the first bend that is in contact with the lands. (See Figure 4.)
6. Bring the clean tip, free of any solder, bevel face down on the wire solder at the inside bend of the joint. Hold for a moment, until the solder has wetted to the leads and lands.
7. Keeping the bevel flat on the leads, draw the blade toward the toe and off the end of the lead.

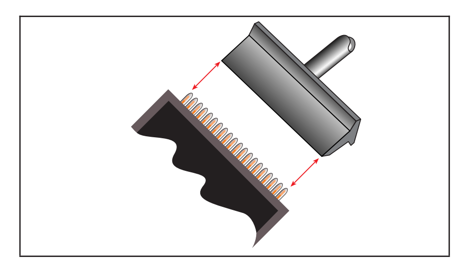


Figure 1 Select Tip

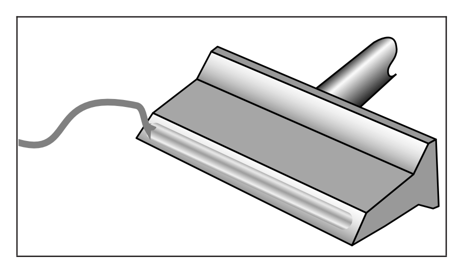


Figure 2 Tin Tip

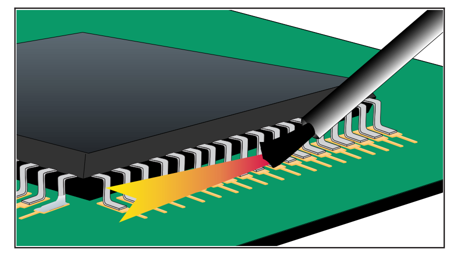


Figure 3 Apply Flux

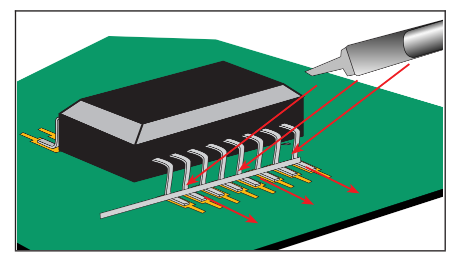


Figure 4 Place Solder

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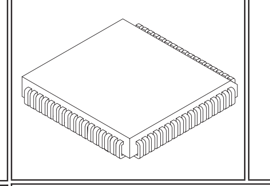
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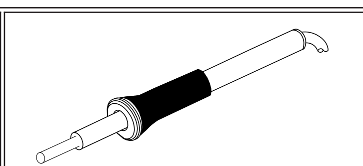
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J-Lead Installation

Wire Solder Method





Product Class: R, F, W, C
Skill Level: Advanced
Level of Conformance: High

EQUIPMENT REQUIRED

Soldering system
Flat blade surface mount installation tip
Vacuum pick-up tool
Damp sponge

OPTIONAL EQUIPMENT

Tweezers

MATERIALS

Flux-cored solder (0.7 mm suggested)
Flux
Cleaner

PROCEDURE

1. Install selected flat blade tip into soldering handpiece.
2. Start with tip temperature of approximately 315°C and change as necessary.
3. Position component ensuring proper lead-to-land alignment. Hold component in place using the vacuum pick-up tool or tweezers. (See Figure 1.)
4. Apply flux and tack solder opposing corner leads. (See Figure 2.)
5. Apply flux to remaining lead/land areas of the row to be soldered. (See Figure 3.)
6. Cut a piece of flux-cored solder approximately 3/4 the length of one side of the component.
7. Place the piece of solder onto the lead/land junctions of the side to be soldered. (See Figure 4.)
8. Clean tip using a damp sponge.
9. Place tip on the first lead/land junction of the side. Observe solder melt. Slowly move tip along remaining lead/land junctions to form proper solder fillets at each joint. (See Figure 5.)
10. Repeat steps 5 - 9 on remaining sides of component.
11. Re-tin tip.
12. Clean, if required, and inspect.

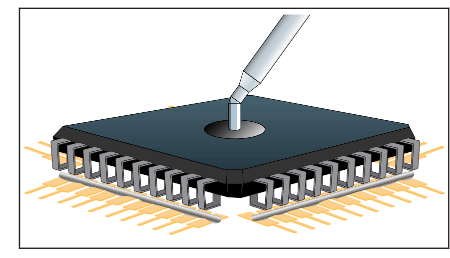


Figure 1 Position Component

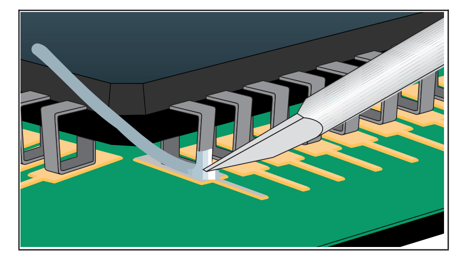


Figure 2 Tack Lead

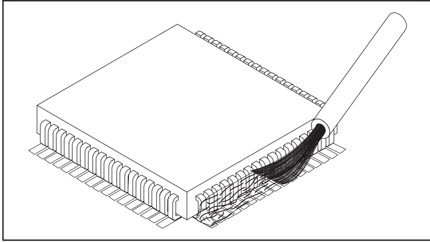


Figure 3 Apply Flux

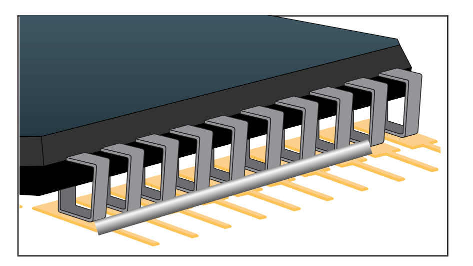


Figure 4 Solder Application

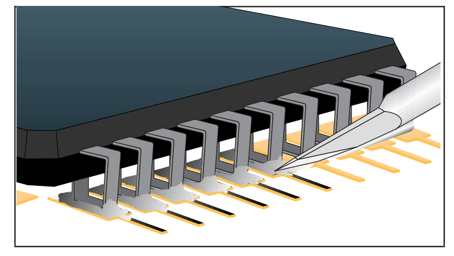
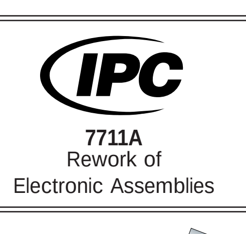


Figure 5 Solder Leads

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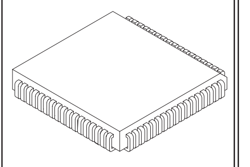
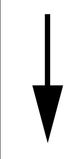
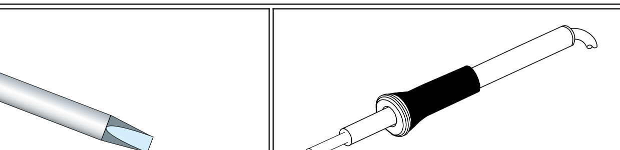
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Rework of
Electronic Assemblies

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Number: **5.6.2**

J-Lead Installation

Point-to-Point Method

Product Class: R, F, W, C
Skill Level: Intermediate
Level of Conformance: High

EQUIPMENT REQUIRED

Soldering system
Damp sponge
Chisel tip
Vacuum pick-up tool

OPTIONAL EQUIPMENT

Tweezers

MATERIALS

Flux-cored solder
Flux
Cleaner

PROCEDURE

1. Install chisel tip into soldering handpiece.
2. Start with tip temperature of approximately 315°C and change as necessary.
3. Position component ensuring proper lead-to-land alignment. Hold component in place using the vacuum pick-up tool or tweezers. (See Figure 1.)
4. Apply flux and tack solder opposing corner leads. (See Figure 2.)
5. Apply flux to remaining lead/land areas of the row to be soldered. (See Figure 3.)
6. Clean tip using a damp sponge. (See Figure 4.)
7. Position chisel tip at intersection of lead and land. Apply solder to side of lead/land area to form proper solder fillet. (See Figure 5.)
8. Repeat step 7 on remaining leads of component.
9. Re-tin chisel tip with solder.
10. Clean, if required, and inspect.

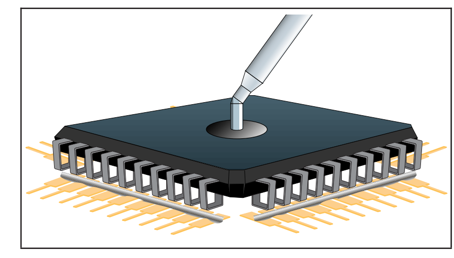


Figure 1 Position Component

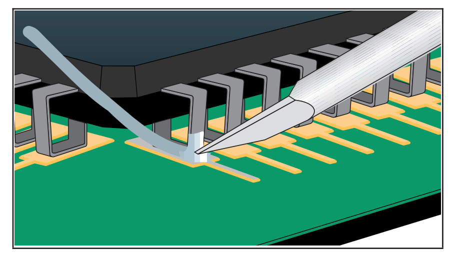


Figure 2 Tack Lead

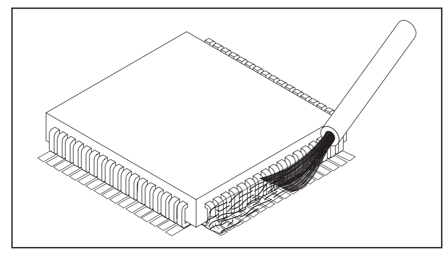


Figure 3 Apply Flux

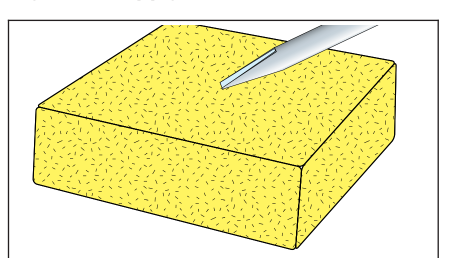


Figure 4 Clean Tip

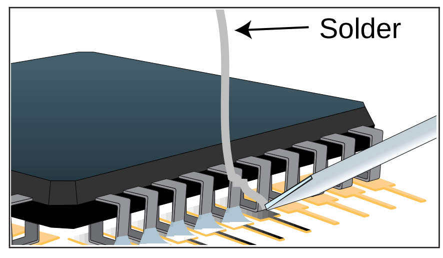


Figure 5 Solder Leads

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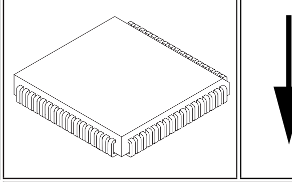
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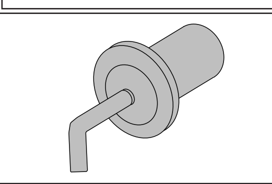
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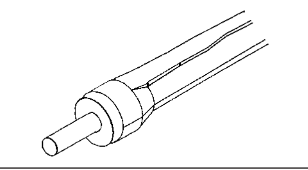
Number: **5.6.3**

J-Lead Installation

Solder Paste Method/Hot Air Pencil







Product Class: R, F, W, C
Skill Level: Advanced
Level of Conformance: High

EQUIPMENT REQUIRED

Hot air pencil
Hot air tip
Solder paste dispenser

OPTIONAL EQUIPMENT

Tweezers

MATERIALS

Solder paste
Cleaner
Tissue/wipe

PROCEDURE

1. Install tip into hot air pencil.
2. Set heater temperature of approximately 425°C and change as necessary.
3. Apply a small bead of solder paste along the land pattern using a dispenser. (See Figure 1.)
4. Position component onto lands using a vacuum pick up tool or tweezers. (See Figure 2.)
5. Adjust pressure output so hot air scorches a tissue from approximately 0.5 cm away. (See Figure 3.)
6. Direct hot air over solder paste/component termination at a distance of 2.5 cm to pre-dry solder paste. (See Figure 4.)
7. When pre-drying is observed (paste has dull, flat appearance), move tip closer (0.5 cm) and heat until complete solder melt is observed. (See Figure 5.)
8. Clean, if required, and inspect.

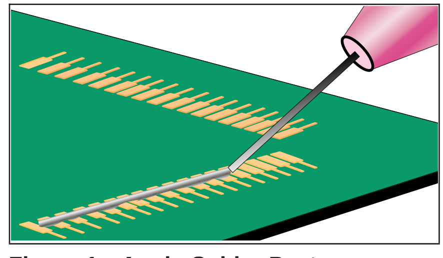


Figure 1 Apply Solder Paste

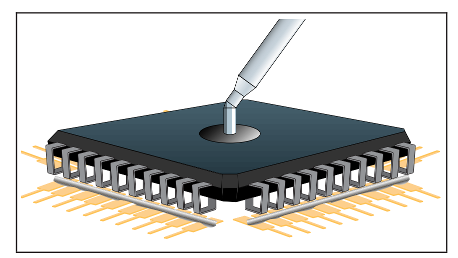


Figure 2 Position Component

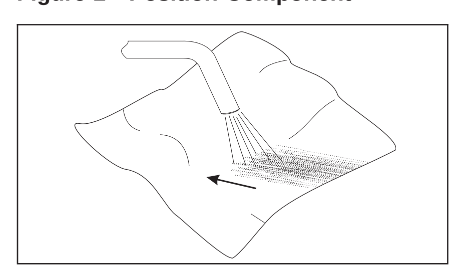


Figure 3 Adjust Pressure

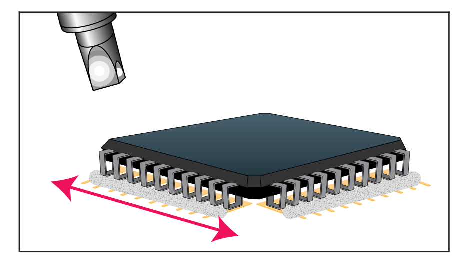


Figure 4 Pre-dry Paste

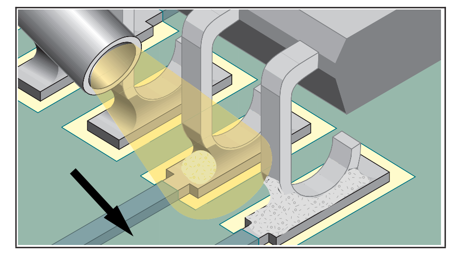


Figure 5 Melt Joints

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Revision: Date: 2/98	

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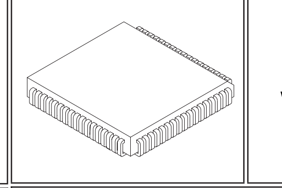
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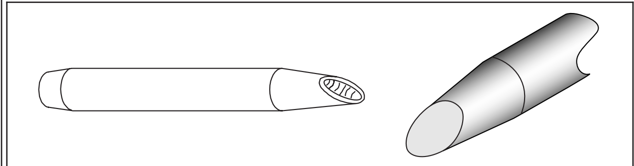
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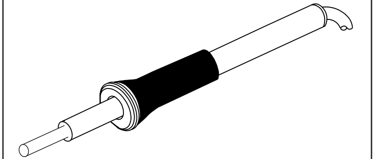
Number: **5.6.4**

J-Lead Installation

Multi-Lead Method







Product Class: R, F, W, C
Skill Level: Intermediate
Level of Conformance: High

EQUIPMENT REQUIRED

Soldering system
Flat faced tip or cup
Flux
Flux-cored solder

MATERIALS

Cleaner
Tissue/wipe

PROCEDURE

1. Install tip into soldering handpiece.
2. Start with tip temperature of approximately 315°C and change as necessary.
3. Align the component carefully and solder it to the board at diagonally opposite corners to fix it in place. (See Figure 1.)
4. Clean tip using damp sponge.
5. Apply solder to the face of the tip to cover approximately 1/2 of the face, keeping the solder down toward the end of the tip, and add about the same amount to the top end of the tip, also at the heel. The precise amount of solder will vary between different types of components. (See Figure 2.)
6. Work with one side at a time, and start with a side that does not include a tacked joint.
7. Bring the tip in at a 45° angle in relation to the row of leads. The tip will make contact with the leads and lands where they meet. (See Figure 3.)
8. Maintaining the same angle, draw the tip down the row of leads slowly and steadily. (See Figure 4.)
9. Clean, if required, and inspect.

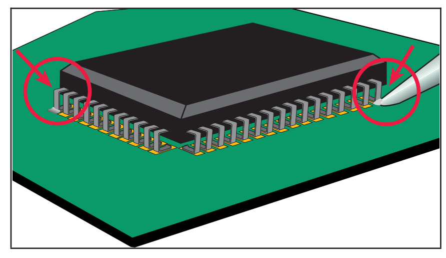


Figure 1 Solder at Corners

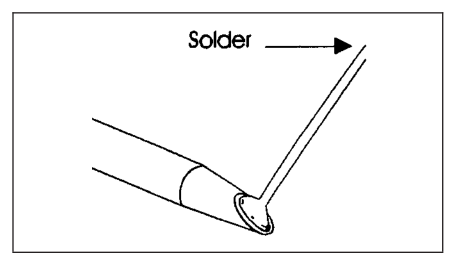


Figure 2 Apply Solder to Tip

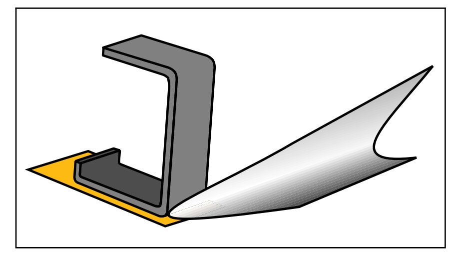


Figure 3 Tip in Contact with Heel

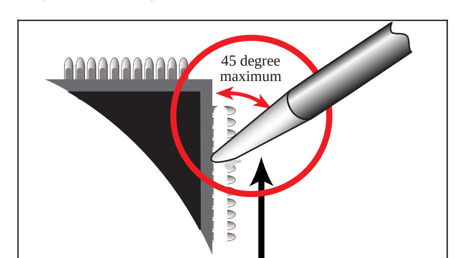


Figure 4 Draw Tip Down

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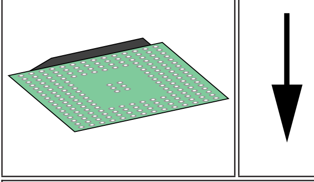
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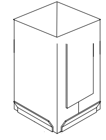
Revision:
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Number: **5.7.1**

BGA/CSP Installation

Using Wire Solder to Prefill Lands





Product Class: R,F,W,C
Skill Level: Advanced
Level of Conformance: High

EQUIPMENT REQUIRED

Hot air or hot gas reflow system (representative examples shown by Figures 1-4)
Gas focusing nozzle (sized to BGA dimensions)
Gas supply (if other than ambient atmosphere)
Preheat method (oven, hotplate, high intensity lamp)

OPTIONAL EQUIPMENT

Bake-out (vacuum, convection) oven
X-ray inspection system
Forced (ambient) air cooling system
Inert gas supply, if used
Microscope/vision system

MATERIALS

Flux-cored solder
Flux
Cleaner

PROCEDURE SUMMARY

The procedure outlined below is generic in nature and identifies the procedural steps which need be accomplished to effect BGA or CSP installation. Each step must be tailored to accommodate the attributes and characteristics of the specific system being used (system manufacturers will customarily provide generalized operating procedures which must be further refined to achieve optimum results).

PROCEDURAL PRECONDITIONS

The following preconditions shall be accomplished prior to performing the procedure:

1) Develop a time/temperature profile (TTP) for the specific BGA and PWA. (See 1.9, Process Goals and Guidelines.)

   NOTE: If plastic body or tape body components are used, see IPC J-STD-020 (Moisture/Reflow Sensitivity Classification for Plastic Integrated Circuit Surface Mount Devices) for information on moisture sensitivity classification tests, preconditioning, and attachment.

2) Bake the PWA to remove entrained moisture which may, if not removed, precipitate measling or delamination.

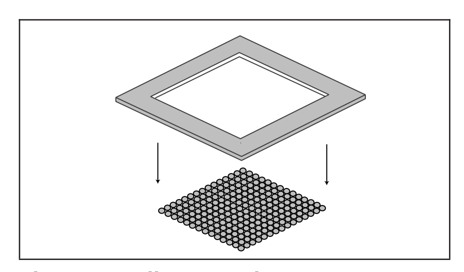


Figure 1 Align Template

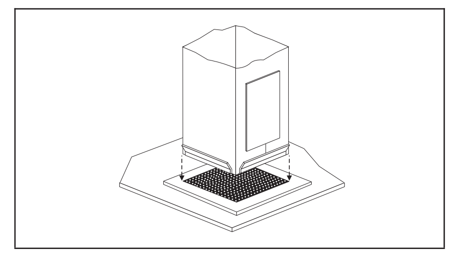


Figure 2 Align Nozzle

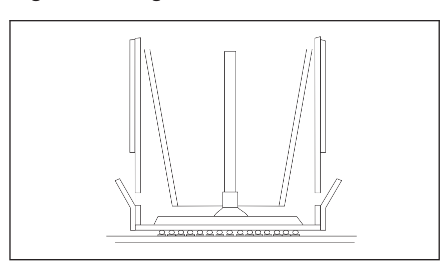


Figure 3 Ball/Land Contact

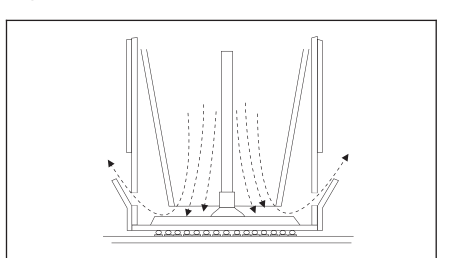


Figure 4 Begin Reflow

Number: **5.7.1**

Subject: **BGA/CSP Installation Using Wire Solder to Prefill lands**

Revision:

Date: 2/98

PROCEDURE STEPS

NOTE: Some systems do not include integrated preheating capability and it may be necessary to preheat the PWA and BGA separately.

1. Prefill lands with flux-cored solder, clean PWA surface and inspect.
2. Place the PWA in the system work piece holder.
3. Coat the prefilled lands with flux.
4. Set hot gas reflow system to achieve the TTP defined by procedural analysis.
5. Perform alignment of gas nozzle to component location (use template, vision system or x-y locator as available/appropriate).
6. Using component placement aids available (vacuum placement pick, x-y locator, etc.), place BGA onto land area while observing indexing/keying indicators to assume proper theta orientation.
7. Bring gas focusing nozzle into reflow position and align nozzle with component.
8. Perform TTP reflow cycle defined by procedural analysis.
9. Perform accelerated cooling cycle if appropriate.
10. Clean PWA as appropriate to customer requirements.
11. Perform x-ray inspection of PWA if appropriate.



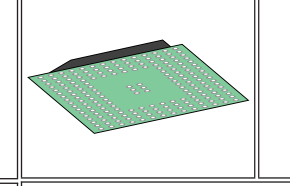
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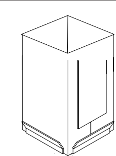
Revision:
Date: 2/98

Number: **5.7.2**

BGA/CSP Installation

Using Solder Paste to Prefill Lands





Product Class: R,F,W,C
Skill Level: Advanced
Level of Conformance: High

EQUIPMENT REQUIRED

Hot air or hot gas reflow System (representative examples shown by Figures 1-4)
Gas focusing nozzle (sized to BGA dimensions)
Gas supply (if other than ambient atmosphere)
Preheat method (oven, hotplate, high intensity lamp)

OPTIONAL EQUIPMENT

Bake-out (vacuum, convection) oven
X-ray inspection system
Forced (ambient) air cooling system
Inert gas supply, if used
Microscope/vision system

MATERIALS

Solder paste (paste defined in 1.9.4)
Cleaner

PROCEDURE SUMMARY

The procedure outlined below is generic in nature and identifies the procedural steps which need be accomplished to effect BGA or CSP installation. Each step must be tailored to accommodate the attributes and characteristics of the specific system being used (system manufacturers will customarily provide generalized operating procedures which must be further refined to achieve optimum results).

PROCEDURAL PRECONDITIONS

The following preconditions shall be accomplished prior to performing the procedure:

1) Develop a time/temperature profile (TTP) for the specific BGA and PWA. (See 1.9, Process Goals and Guidelines.)

   NOTE: If plastic body or tape body components are used, see IPC J-STD-020 (Moisture/Reflow Sensitivity Classification for Plastic Integrated Circuit Surface Mount Devices) for information on moisture sensitivity classification tests, preconditioning, and attachment.

2) Bake the PWA to remove entrained moisture which may, if not removed, precipitate measling or delamination.

PROCEDURE STEPS

NOTE: Some systems do not include integrated preheating capability and it may be necessary to preheat the PWA and BGA separately.

1. Clean PWA surface and lands.
2. Apply solder paste (stencil, screen, dot dispense, as appropriate).

Figure 1 Align Template

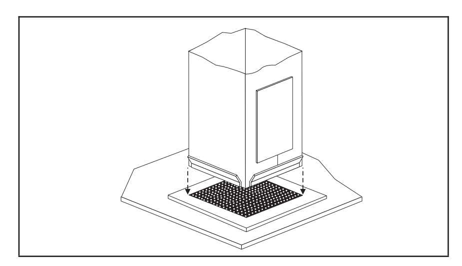


Figure 2 Align Nozzle

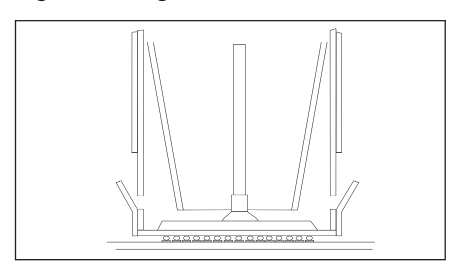


Figure 3 Ball/Land Contact

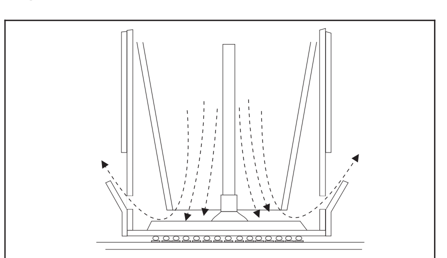


Figure 4 Begin Reflow

3. Place the PWA in the system work piece holder.
4. Set hot gas reflow system to achieve the TTP defined by procedural analysis.
5. Perform alignment of gas nozzle to component location (use template, vision system or x-y locator as available/appropriate).
6. Using component placement aids available (vacuum placement pick, x-y locator, etc.), place BGA onto land area while observing indexing/keying indicators to assume proper theta orientation.
7. Bring gas focusing nozzle into reflow position and accomplish fine alignment.
8. Perform TTP reflow cycle defined by procedural analysis.
9. Perform accelerated cooling cycle if appropriate.
10. Clean PWA as appropriate to customer requirements.
11. Perform x-ray inspection of PWA if appropriate.

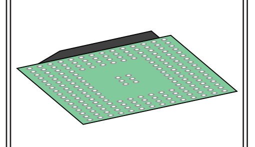


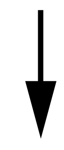
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Number: **5.7.3**

BGA Reballing Procedure





Product Class: R, C
Skill Level: Advanced
Level of Conformance: High

EQUIPMENT REQUIRED

Solder removal system
Convective reflow station
Reballing fixture

OPTIONAL EQUIPMENT

Reflow oven
Bake-out (vacuum, convection) oven

MATERIALS

Flux
Cleaner
Tissue/wipes
Solder spheres

NOTE

Moisture sensitive components (as classified by IPC/JEDEC J-STD-020 or equivalent documented procedure) must be handled in a manner consistent with J-STD-033 or an equivalent documented procedure.

CAUTION

Verify component can withstand the multiple reflow cycles.

PROCEDURE

1. Remove excess solder in accordance with procedures 4.1.2, 4.1.3, or 4.2.1
2. Clean and inspect BGA for coplanarity.
3. Apply flux to land on BGA. (Figure 1.)
4. Insert the BGA into the applicable reballing fixture and secure. (Figure 2.)
5. Carefully pour solder sphere into fixture. (Figure 3.)
6. Drain off all excess spheres. Ensure all holes in fixture have a solder sphere.
7. Reflow solder spheres using the established profile. (Figure 4.)
8. Allow BGA to cool and remove from fixture.
9. Clean (if necessary) and inspect the BGA.



Figure 1



Figure 2



Figure 3

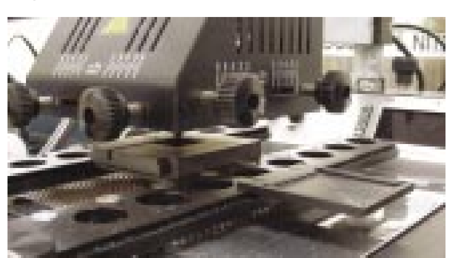
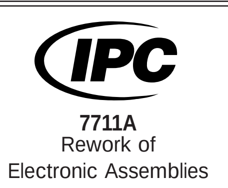


Figure 4

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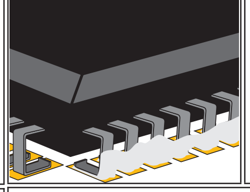

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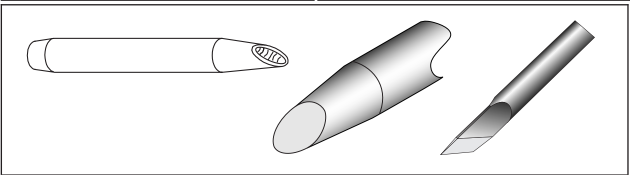
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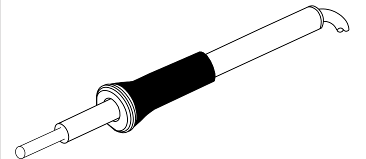
Number: **6.1.1**

Removing Shorts on J-Leads

Draw Off Method







Product Class: R, F, W, C
Skill Level: Intermediate
Level of Conformance: High

EQUIPMENT REQUIRED

Soldering system
Soldering handpiece
Appropriate tip*

MATERIALS

Flux
Cleaner

NOTES

*Choice of the proper tip is based on tools available and the number of bridged leads. See tips illustrated above.

PROCEDURE

1. Install appropriate tip.
2. Start with the coolest tip temperature possible (approximately 280°C) and change as necessary. The surface attraction of the solder to the tip must overcome that of the leads.
3. Clean tip using a damp sponge.
4. Apply flux to the bridged leads. (See Figure 1.)
5. Bring the tip in with the bottom as flat as space will permit, with the toe towards the component and between the bridged leads. When using the scalpel tip, the flat bottom instead of the toe is towards the component. (See Figure 2.)
6. With the bottom still flat, stand the tip up so the side contacts the shoulders of the leads and the bridge between them.
7. After a brief pause to allow the solder to flow to the tip surface, gently move the tip straight out from the component body, drawing the bridge with it. (See Figure 3.)
8. If you did not draw off enough solder, allow leads to cool and repeat steps 2-5.
9. Clean, as required, and inspect.

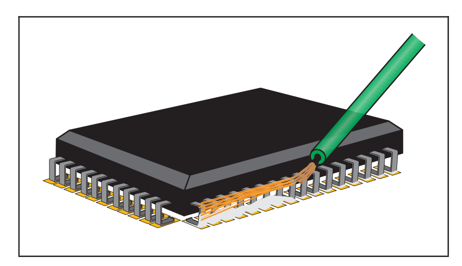


Figure 1 Apply Flux

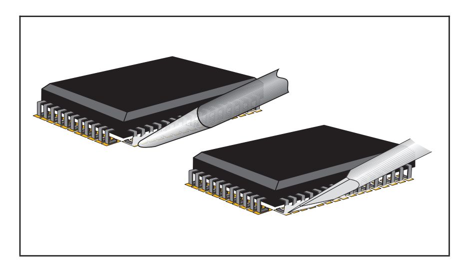


Figure 2 Tip Should Be Flat

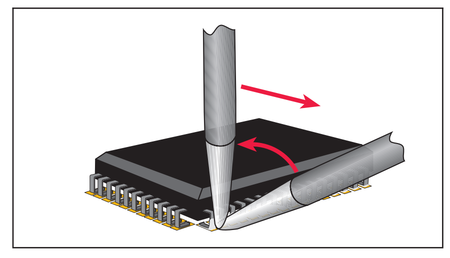


Figure 3 Move tip

Number: **6.1.1**	Subject: **Removing Shorts on J-Leads**
Revision: Date: 2/98	

NOTES



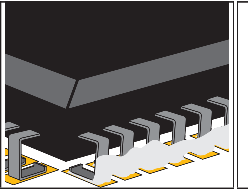
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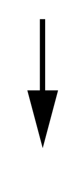
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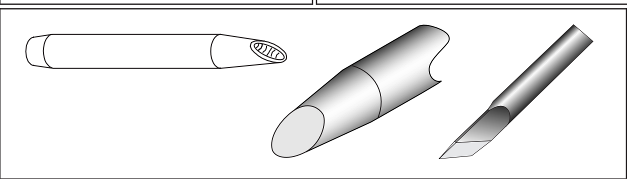
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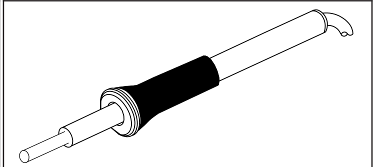
Removing Shorts on J-Leads

Respread Method









Product Class: R, F, W, C
Skill Level: Intermediate
Level of Conformance: High

EQUIPMENT REQUIRED

Soldering system
Soldering iron
Appropriate tip*

MATERIALS

Flux
Cleaner

NOTES

*Choice of the proper tip is based on tools available and the number of bridged leads. See tips illustrated above.

PROCEDURE

1. Install appropriate tip.
2. Start with the coolest tip temperature possible (approximately 315°C) and change as necessary. The surface attraction of the solder to the tip must overcome that of the leads.
3. Clean tip using a damp sponge.
4. Apply flux to the bridged leads. (See Figure 1.)
5. Bring the tip in at a 45° angle in relation to the row of leads. The side of the tip will make contact with the leads, the toe with the lead and the land.
6. Draw the tip, and the liquid bridge with it, down the row, respreading the solder across the rest of the leads. (See Figure 2.)
7. Clean, as required, and inspect.

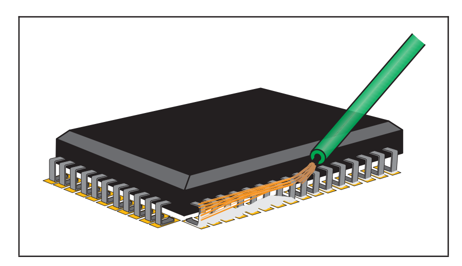


Figure 1 Apply flux

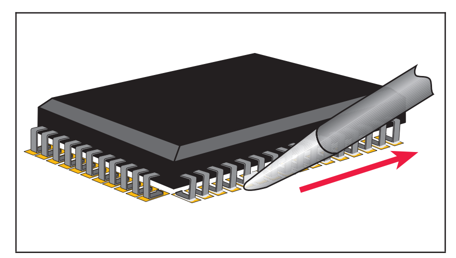


Figure 2 Draw Tip Down Row

NOTES



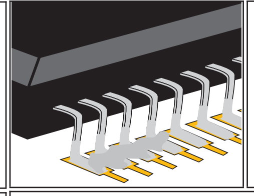
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Rework of
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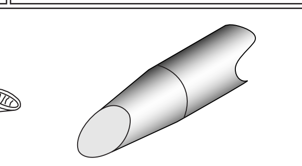
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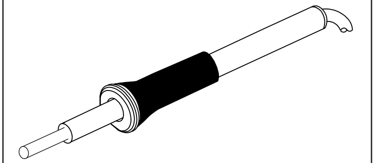
Number: 6.1.3

Removing Shorts Between Gull Wing

Draw Off Method







Product Class: R, F, W, C
Skill Level: Intermediate
Level of Conformance: High

EQUIPMENT REQUIRED

Soldering system
Soldering iron
Cup or flat faced tip

MATERIALS

Flux
Cleaner

PROCEDURE

1. Install appropriate tip.
2. Start with the coolest tip temperature possible (approximately 280°C) and change as necessary. The surface attraction of the solder to the tip must overcome that of the leads.
3. Apply flux to the bridged leads. (See Figure 1.)
4. Clean tip using a damp sponge.
5. Hold the tip so the shaft runs parallel to the row of leads, putting the side of the tip toward the side of the component. The angle between the side of the tip and the side of the component can be up to 30 degrees depending on operator preference. (See Figure 2.)
6. Bring the flat surface of the tip down on the bridge, wait for reflow, then draw the bridge gently down the leads and away from the component. (See Figure 3.)
7. If you did not get all the solder on the first try, wipe the excess solder from the tip and repeat the procedure.
8. If you did not draw off enough solder, allow leads to cool and repeat steps 2-5.
9. Clean, as required, and inspect.

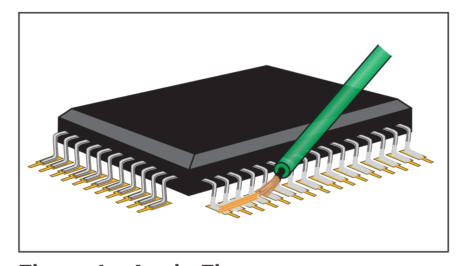


Figure 1 Apply Flux

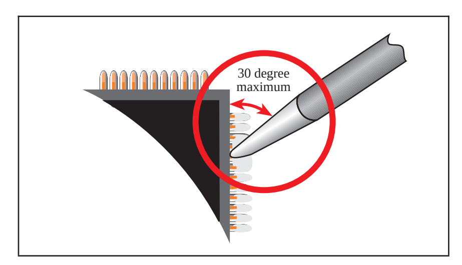


Figure 2 Hold Tip Parallel

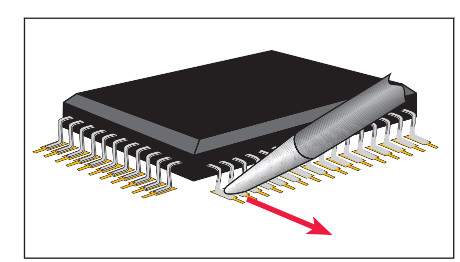


Figure 3 Draw Tip Away From Component

NOTES



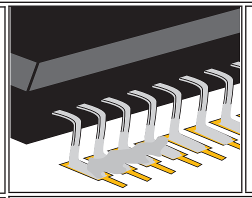
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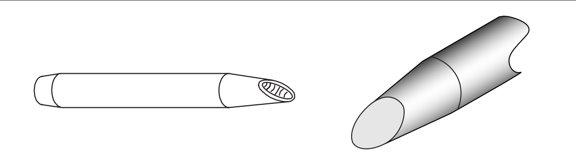
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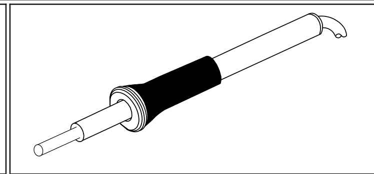
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Removing Shorts Between Gull Wing

Respread Method







Product Class: R, F, W, C
Skill Level: Intermediate
Level of Conformance: High

EQUIPMENT REQUIRED

Soldering system
Soldering iron
Cup of flat faced tip

MATERIALS

Flux

PROCEDURE

1. Install appropriate tip.
2. Start with the coolest tip temperature possible (approximately 315°C) and change as necessary. The surface attraction of the solder to the tip must overcome that of the leads.
3. Clean tip using a damp sponge.
4. Apply flux to the bridged leads. (See Figure 1.)
5. Hold the tip so the toe of the hoof runs parallel to the row of leads, that is, the side of the tip toward the side of the component. The angle between the side of the tip and the side of the component would ideally be zero for maximized heat transfer, but can be up to 30° depending on operator preference. (See Figure 2.)
6. Bring the tip face down flat onto the bridge and pause for reflow. Draw the tip, and the liquid bridge with it, down the row of leads, respreading the solder across the rest of the leads. (See Figure 3.)
7. Clean, as required, and inspect.

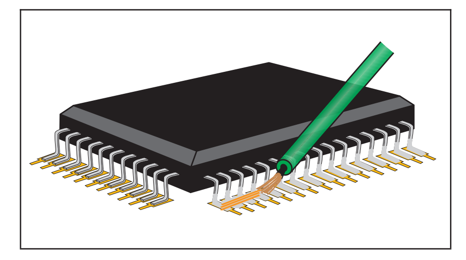


Figure 1 Apply Flux

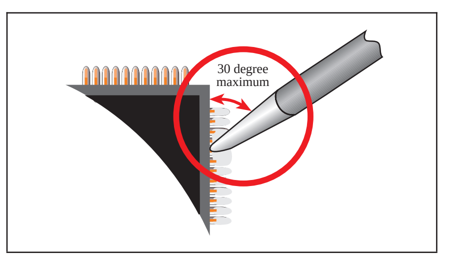


Figure 2 Hold Tip Parallel

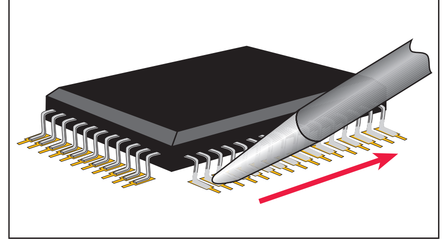


Figure 3 Draw Tip Down Row

NOTES

8.1 Splicing

1. THE PROCESS OF WIRE SPLICING IS USED IN TWO CASES:

a. When a self-lead component (inductor, transformer, choke, etc.) is installed (either during assembly or as a replacement for a failed component) and,

b. In the process of repairing a damaged wire when removal and replacement of the entire wire length is not feasible.

2. THE FOUR MOST COMMON SPLICES USED ARE:

- *Mesh Splices* Mesh splices require the least wire length in order to complete the splice and result in a splice diameter only slightly larger than the diameter of the wire used.
- *Wrap Splices* Wrap splices require a longer wire length in order to complete the splice and have a splice diameter equal to three times the diameter of the wire used.
- *Hook Splices* Hook Splices require the most wire length in order to complete the splice and have a splice diameter equal to three times the diameter of the wire used.
- *Lap Splices* Lap splices, like mesh splices, require a minimal amount of original wire length and may be used to perform repair of a damaged wire when:

a. Sufficient slack is available in the wire to achieve the necessary overlap, and

b. The repaired wire will not be subjected to longitudinal stress after repair.

3. WIRE SPLICING

Locating/Isolating Damage Locate the damaged wire. If the wire is broken, determine if both sections are available. Isolate the damaged area by using point-to-point resistance measurements.

Note: If the wire was broken (separated) by a cutting action, the cut ends can be spliced at the point of breakage/separation. If the wire was broken (separated) by a pulling action, e.g., stretching or pulling until separation, then the wire strands on both sides of the break will have suffered hidden mechanical damage in the form of stretching, elongation and reduction of individual strand diameter. In such cases, where separation was caused by a pulling action, it is desirable to remove (cut-out) wire which could have been damaged by stretching and installing a longer splice than would normally be used.

4. FEASIBILITY OF REPAIR

Prior to repairing damaged wires, the following considerations must be made:

- Should damaged wires be replaced in their entirety
- Should wires be repaired using solder sleeves
- If complete replacement is not feasible, determine if one section of wire may be replaced thereby limiting the number of splices to one
- If no section of the damaged wire can be replaced, splice in a replacement section of wire with two splices

5. INSULATED CONDUCTOR STRIPPING

Insulated conductors should be stripped a distance longer than required for the solder connection. This allows for easier forming of the conductor. The excess conductor shall be trimmed off prior to soldering. The following stripping methods are recommended.

a. Thermal wire strippers are to be used on insulations that will melt upon application of heat. This method is preferred because it minimizes the possibility of conductor damage.

Caution: Do not use mechanical strippers on wire smaller than AWG-20, as the strippers may stretch the wire.

b. Mechanical strippers are to be used on insulations that cannot be thermally stripped. This method does not apply to enamel insulation.

c. Chemical stripper is used on conductors that have an enamel/varnish coating for insulation.

1) Follow the manufacturer's instructions on the length of time for the chemical reaction to take place.

2) The stripper may have to be neutralized. Follow the manufacturer's safety precautions on both equipment and personnel.

Warning: Chemical strippers contain ingredients harmful to both skin and eyes. Prescribed protective clothing, including industrial goggles/spectacles, shall be worn when opening the container and during use. If stripper gets on skin, wash immediately with fresh water and soap and rinse freely. If stripper gets into eyes, flood with large quantity of fresh water. Do not apply ointments or salve, obtain medical aid at once. Follow manufacturer's safety instructions.

6. TINNING

Background: Once a conductor is exposed to the environment, oxidation begins to take place. The tinning of a conductor is important to ensure a quality solder connection. Tinning stranded wire reduces the probability of wire damage during forming of necessary bends.

Note: Do not tin wires that will be used on the mesh splice.

Wicking: Wicking of solder underneath the wire insulation is not usually a problem, as long as the insulation is capable of withstanding the heat and as long as the wire does not have to remain flexible at the point of the splice. If the insulation cannot withstand the heat of tinning/soldering, or if the wire must be bent, or remain flexible at the point of the splice, then it is recommended that an anti-wicking tool be used when tinning the wire and a thermal-shunt or heat-sink be used when soldering the splice.

Flux: Any flux used during tinning or soldering of wire will wick up under the wire insulation. Flux which wicks up under the insulation can not be extracted or removed by cleaning. Therefore, only Rosin Mildly Activated (RMA) type flux should be used when tinning/soldering stranded wire. Flux identified as Rosin Activated (RA) must not be used for tinning/soldering stranded wire because RA flux which wicks up under the insulation contains activators which are corrosive.

Appearance: After tinning, the surface of the tinned stranded wire should be smooth, bright, non-porous and individual strands should be visible. The tinned surface of a solid wire, or a component lead should be smooth, bright and non-porous.

7. TINNING METHODS

Tin all areas that will be soldered during the splicing operation. Anti-wicking tools, if used, should be sized to the diameter of the wire being tinned. Tinning of conductors may be accomplished using either of the following methods.

A. Soldering Irons

1) Select the proper size soldering iron tip.
2) Select a soldering iron tip large enough and a heat setting high enough to ensure solder melt within 2-3 seconds.
3) Ensure that the soldering iron tip and area to be soldered are clean.
4) Form a proper heat bridge approximately one-third the distance down from the insulation/anti-wicking tool.

B. Solder Pots

Note: Due to the lack of mobility, solder pots are used for tinning conductors that are not located inside of equipment or components leads, e.g., cable repair/manufacture, dual inline packages, and discrete components.

1) Ensure wire to be tinned is properly stripped and held by anti-wicking tool or other means of securing wire without damage to insulation.
2) Apply flux to the area of the wire to be tinned.
3) Remove dross from properly heated solder pot.
4) Insert wire into pot to depth of tin desired, hesitating approximately one second to overcome heat sinking effect. Pull away in a swift upward motion.
5) After tinning, it must be cleaned and rinsed in accordance with shop practices to remove contaminants, and inspected to ensure flux residue has been removed.

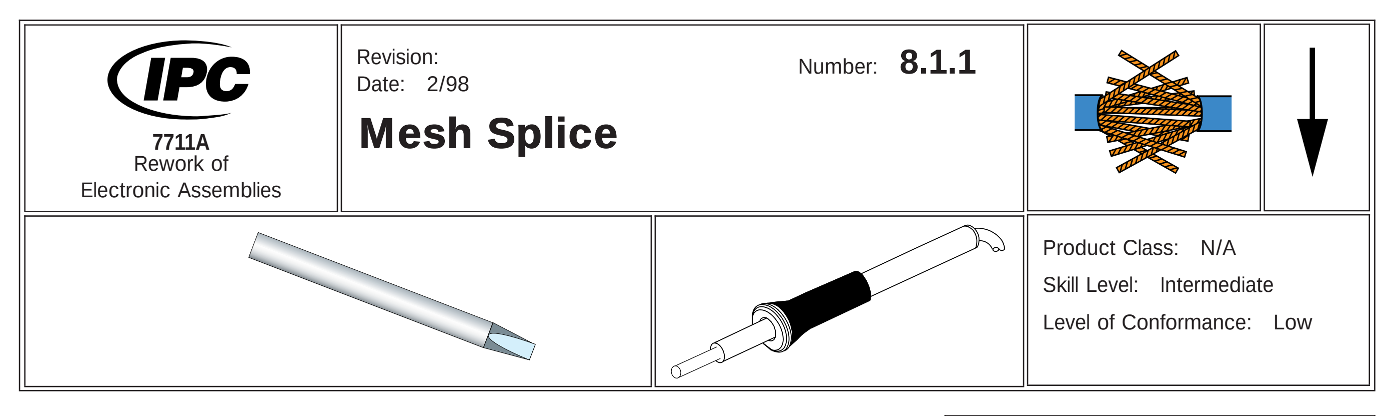
8. SOLDERING

a. Apply solder to the junction of the iron and wire, forming a heat bridge, and allow it to soak into the wire.

b. Move the solder and the iron up the wire toward the insulation/anti-wicking tool, ensuring a continuous flow of solder throughout the entire tinning process.

c. When the iron and solder reach the insulation/anti-wicking tool, hesitate momentarily and then continue to flow in solder and work back down the wire. As you bring the solder and iron off the end of the wire, the excess solder and all the oxidation will follow the iron off the wire.

d. Clean the wire using approved shop practices to remove flux residue. The cleaned wire should have a bright shiny appearance.



Mesh Splice

EQUIPMENT REQUIRED

Soldering system
Soldering handpiece
Chisel tip

MATERIAL

Flux
Flux-cored solder
Insulative tubing

NOTE

Prior to fanning the wires of this type splice, position the insulation sleeving/tubing over the wire. Ensure that the sleeving/tubing length is sufficient to extend over the wire's insulation, on both sides of the spliced area, a distance of three times the wire insulation diameter. The tubing's inside diameter should be selected to facilitate (after shrinking) a snug, firm fit over the wire insulation.

PROCEDURE

1. Install tip.
2. Start with tip temperature of approximately 260°C and change as necessary.
3. Form the mesh splice by fanning the wire strands on both untinned wires into a cone shape. (See Figure 1.)
4. Gently begin meshing the wires together a minimum of 1.3 cm so that the strands interlace evenly and of equal length. (See Figure 2.)
5. Twist the wires slowly using a slight pulling motion to restore the original lay of the wire. Do not overtwist. (See Figure 3.)

WIRE SPLICING

6. Select appropriate heating element to establish a heat bridge and minimize the effect of solder wicking beneath insulation. Solder in accordance with paragraph 8 in 8.1. (See Figure 4.)

NOTE

Flux contained in flux-cored solders should be sufficient to clean and solder splices. If external flux is used, the chance of solder wicking beneath the insulation of stranded wire is increased.

7. Clean, if required, and inspect.
8. Position insulation sleeve/tubing over the spliced area, apply heat to shrink to a snug fit over the splice and wire insulation. (See Figure 5.)

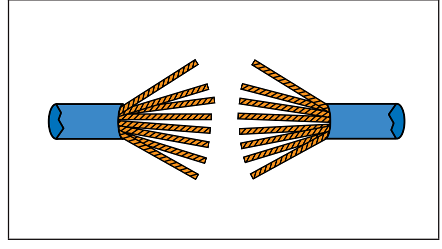


Figure 1 Strip and Fan Wire Strands

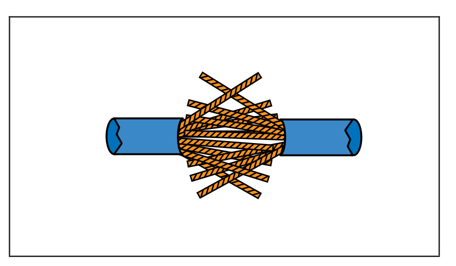


Figure 2 Mesh Wire Strands

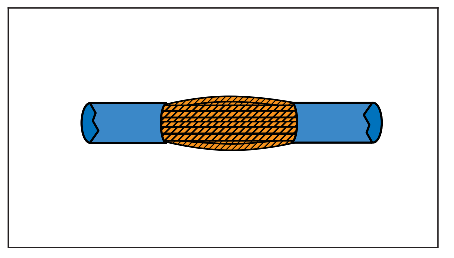


Figure 3 Smooth Down Strands

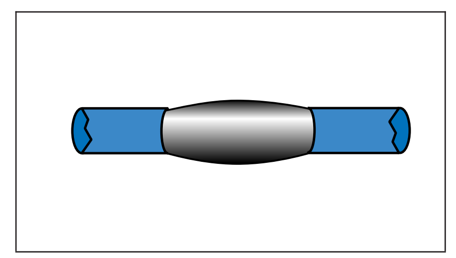


Figure 4 Solder Connections

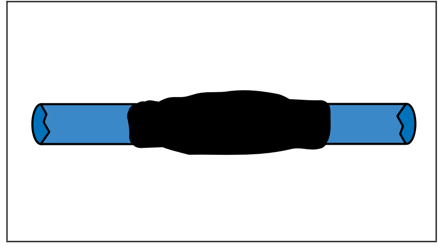
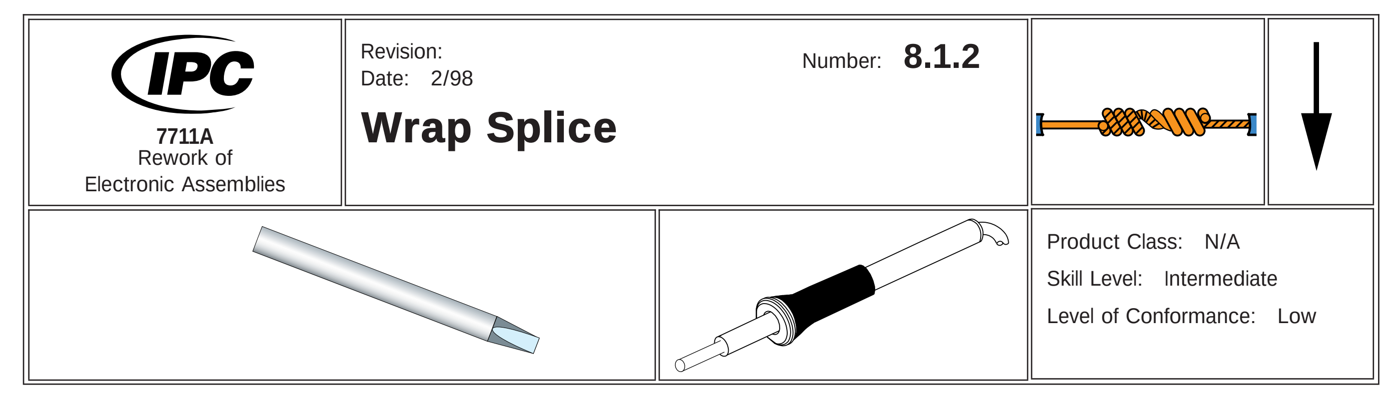


Figure 5 Cover with Heat-Shrinkable Tubing

NOTES



Wrap Splice

EQUIPMENT REQUIRED

Soldering system
Soldering handpiece
Chisel tip

MATERIALS

Flux
Flux-cored solder
Insulative tubing

NOTE

The contact area between the two wires shall be a minimum of three wraps (not twist) of each wire around the other.

PROCEDURE

1. Install tip.
2. Start with tip temperature of approximately 260°C and change as necessary.
3. Strip and pre-tin stranded wires in accordance with guidelines identified in paragraph 7 in 8.1. (See Figure 1.)
4. Place sleeving/tubing/wire designations, etc. onto wire. Ensure that the sleeving/tubing length is sufficient to extend over the wire's insulation, on both sides of the spliced area, a distance of three times the wire insulation diameter. The tubing's inside diameter should be selected to facilitate (after shrinking) a snug, firm fit over the wire insulation.

WIRE SPLICING

5. Position wires in an ''X'' pattern. Securing one wire firmly, begin the wrap motion of the opposite wire until one turn is completed. (See Figures 2 & 3.)
6. Firmly secure the remaining wire and begin wrap motion in the opposite direction. (See Figure 3.) Upon completion of one wrap on each wire, complete the wrapping process to obtain the three wire wrap minimum requirement. (See Figure 4.)
7. Terminate any remaining wire length using a flush cut pattern. (This eliminates any wire protrusion that could extend beyond the outer circumference of the wrap and cause damage to the insulation/tubing that could result in a short.) (See Figure 4.)
8. Select appropriate heating element to establish a heat bridge and minimize the effect of solder wicking beneath insulation. Solder in accordance with paragraph 8 in 8.1.

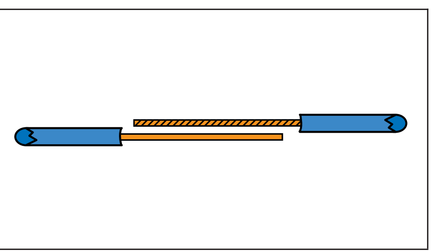


Figure 1 Strip and Tin

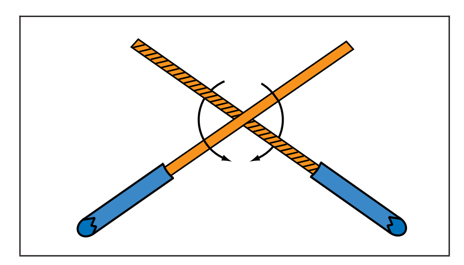


Figure 2 Position in An "X"

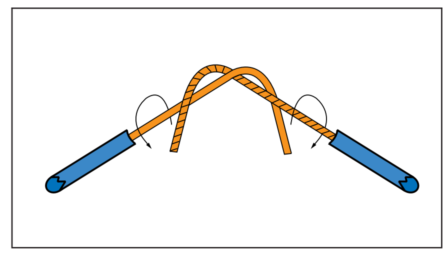


Figure 3 Wrap in Opposite Directions

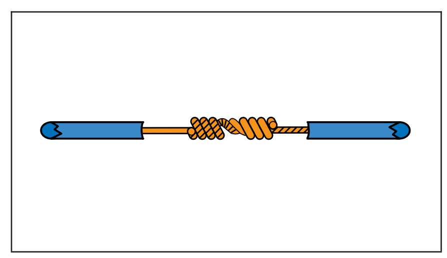


Figure 4 Solder Connection

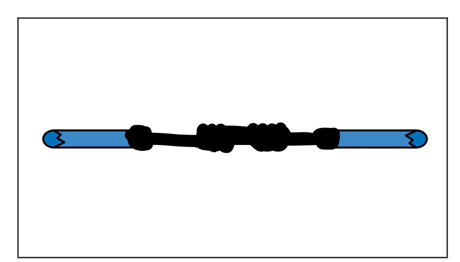
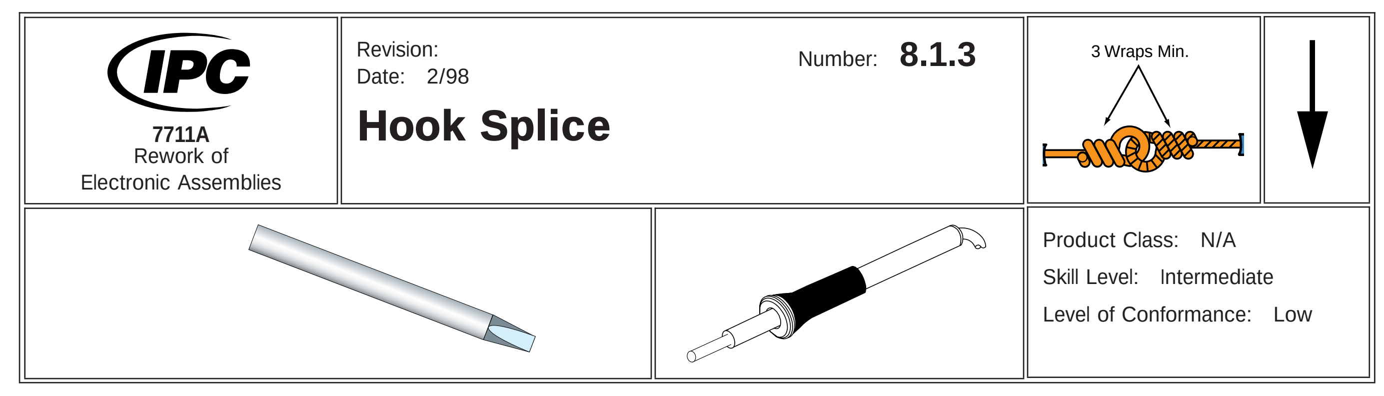


Figure 5 Cover with Heat-Shrinkable Tubing

NOTE

Flux contained in flux-cored solders should be sufficient to clean and solder splices. If external flux is used, the chance of solder wicking beneath the insulation of stranded wire is increased.

9. Clean, as required, and inspect.
10. Position insulation sleeve/tubing over the spliced area, apply heat to shrink to a snug fit over the splice and wire insulation. (See Figure 5.)



EQUIPMENT REQUIRED

Soldering system
Soldering handpiece
Chisel tip

MATERIAL

Flux
Flux-cored solder
Insulative tubing

NOTE

The contact area between the two wires shall be a minimum of three wraps of each wire around itself.

PROCEDURE

1. Install tip.
2. Start with tip temperature of approximately 260°C and change as necessary.
3. Strip and pre-tin stranded wires in accordance with guidelines identified in paragraph 7 in 8.1. (See Figure 1.)
4. Place sleeving/tubing/wire designations, etc., onto wire. Ensure that the sleeving/tubing length is sufficient to extend over the wire's insulation, on both sides of the spliced area, a distance of three times the wire insulation diameter. The tubing's inside diameter should be selected to facilitate (after shrinking) a snug, firm fit over the wire insulation.

WIRE SPLICING

5. Form a 180° bend in each wire, ensure that the wire strands have not been separated during this process. (See Figure 2.)
6. Securing one wire firmly, begin the wrap motion of the opposite wire until one turn is completed. (See Figure 3.)
7. Firmly secure the remaining wire and begin wrap motion in the opposite direction. Upon completion of one wrap on each wire, complete the wrapping process to obtain the three wire wrap minimum requirement. (See Figure 4.)
8. Terminate any remaining wire length using a flush cut pattern. (This eliminates any wire protrusion that could extend beyond the outer circumference of the wrap and cause damage to the insulation/tubing that could result in a short.) (See Figure 4.)
9. Select appropriate heating element to establish a heat bridge and minimize the effect of solder wicking beneath insulation. Solder in accordance with paragraph 9 in 8.1.

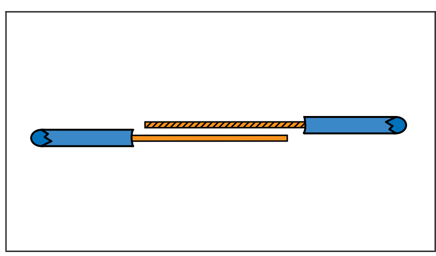


Figure 1 Strip and Tin Wires

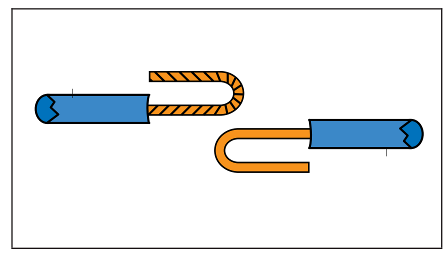


Figure 2 Form 180° Bend

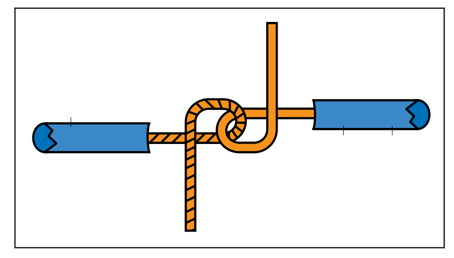


Figure 3 Wrap in Opposite Direction

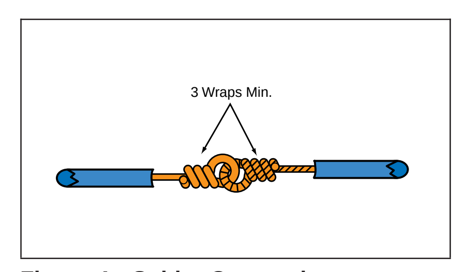


Figure 4 Solder Connections

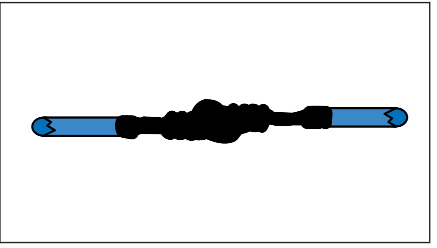
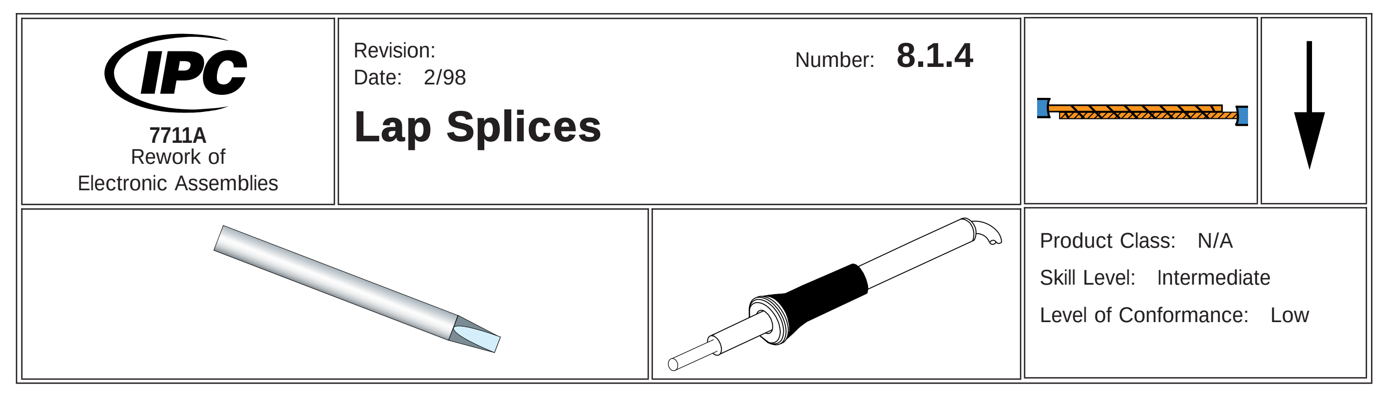


Figure 5 Cover with Heat-Shrinkable Tubing

NOTE

Flux contained in flux-cored solders should be sufficient to clean and solder splices. If external flux is used, the chance of solder wicking beneath the insulation of stranded wire is increased.

10. Clean, as required, and inspect.
11. Position insulation sleeve/tubing over the spliced area, apply heat to shrink to a snug fit over the splice and wire. (See Figure 5.)



EQUIPMENT REQUIRED

Soldering system
Soldering handpiece
Chisel tip

MATERIALS

Flux
Flux-cored solder
Insulative tubing

PROCEDURE

1. Install tip
2. Start with tip temperature of approximately 260°C and change as necessary.
3. Strip the wires. Each wire end should have the same length of insulation removed so that they appear identical. Each wire end should be stripped a minimum of four (four) wire diameters (a wire diameter is the outside diameter of the insulator which covers the conductor). Pre-tin wires in accordance with guidelines in paragraph 7 in 8.1. (See Figure 1.)
4. Place shrink-sleeving/tubing/wire designators, etc. onto the wire to be spliced and slide down the wire far enough to avoid interference during soldering. The inside diameter of the shrink-sleeving should be selected to ensure that a snug, firm, weather-tight seal will exist after shrinking.

NOTE

Step three (below) requires a single strand of wire, approximately 7.5 cm long, to be available for wrapping the overlapped wire ends. It is easiest to strip 7.5 cm of wire by making 3 separate strips (each approximately 2.5 cm long from the spool/reel of repair wire).

5. If possible, position wires on a flat surface so that the tinned lengths of wire overlap and are against each other (like the first two fingers on your hand) and the end of wire ''a'' butts against the ends of the insulation of wire ''b.'' (See Figure 2.) If identical lengths of insulation were removed, then the end of wire ''b'' will butt against the insulation of wire ''a.'' If it is not possible to position the wires on a flat surface, then position the wires as described above and secure in position using hemostats, alligator clips, etc. As a last ditch expedient, the wires can be tack soldered into the described position. If tack soldered, do not add solder, just heat the wires sufficiently to achieve a solder bond between the tinned wires.
6. Using a single strand of wire (approximately #30 awg) from a stranded wire (see Note above), wrap the overlapped wires to achieve sufficient mechanical security to prevent movement of the overlapped ends during soldering. (See Figure 3.)

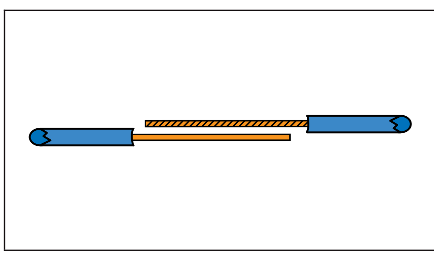


Figure 1 Strip and Tin Wires

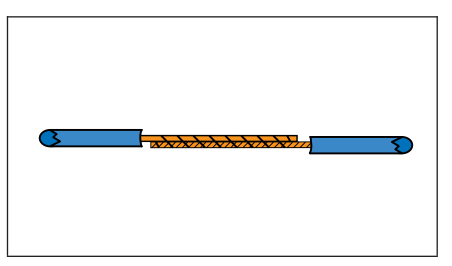


Figure 2 Line Up Wires

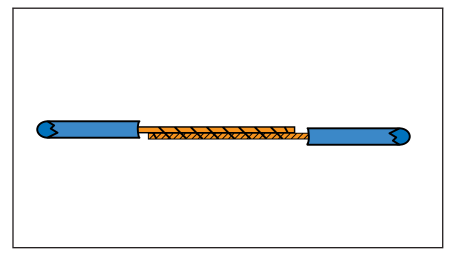


Figure 3 Wrap with #30 Awg Wire

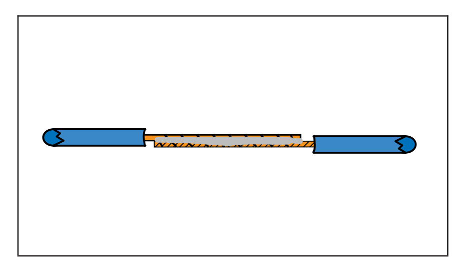


Figure 4 Solder Connection

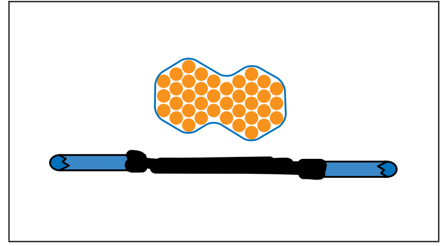


Figure 5 Cover with Heat-Shrinkable Tubing

Number: **8.1.4**	Subject: **Lap Splice**
Revision: Date: 2/98	

NOTE

Do not use magnet or coil wire, due to its insulative enamel coating, to prevent damage to wire during the wrapping procedure.

Use only a single layer of wrapping on the overlapped wires and fold the end of the wire used for wrapping back down against the wrap surface.

7. Select a soldering iron tip appropriate to soldering the overlap splice. Establish a heat bridge in the center of the overlapped wires and add sufficient solder to achieve a complete solder fillet between the full length of the overlapped wires. The completed solder connection may have a slightly convex fillet for the length of the connection, as long as the individual wire wraps used to secure the spliced wires are clearly visible in the solder. (See Figure 4.)
8. Clean the completed connection with the appropriate solvent and visually inspect in accordance with stated requirements.
9. Position insulative sleeving, shrink-sleeving, or protective tubing over the splice, assuring that the splice is centered in the length of the sleeving/tubing. Apply heat to shrink-sleeving as necessary to achieve a tight fit over the splice. Position protective tubing (if used) over shrink-sleeving and mechanically secure as appropriate. (See Figure 5.)



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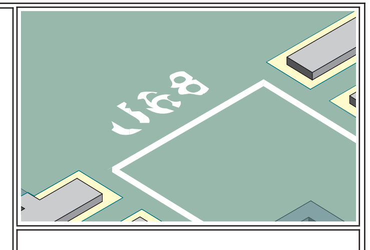
Repair and Modification of Printed Boards and Electronic Assemblies

Revision:

Date: **2/98**

Number: **2.7.1**

Legend/Marking, Stamping Method



Product Class: R, F, W, C
Skill Level: Intermediate
Level of Conformance: High

OUTLINE

This method can be used to add, change or replace legend and markings on printed boards or printed board assemblies. This method uses epoxy ink and an ink stamp to place the legends on the printed board surface in much the same manner as taking a ‘‘finger print.’’

REFERENCES

2.1 Handling Electronic Assemblies
2.2 Cleaning
2.5 Baking and Preheating
2.6 Epoxy Mixing and Handling

TOOLS & MATERIALS

Cleaner
Cleaning Wipes
Epoxy Ink
Ink Plate
Ink Roller
Knife
Microscope
Oven
Peg Stamps

PROCEDURE

1. Clean the area.
2. Scrape off any remaining character or legend with a knife and clean the area.

   CAUTION
   Abrasion operations can generate electrostatic charges.
3. Select the appropriate characters from the peg stamp set or have a special stamp made up.
4. Mix the epoxy ink. White is the most common color. Spread a thin even coating of the epoxy ink on the ink plate or on a smooth surface.
5. Gently press the peg stamp into the epoxy coating to coat the character surface.
6. Gently press the peg stamp onto the desired location on the printed wiring board surface. (See Figure 1.)
7. Cure the epoxy ink per the manufacturer’s instructions.

EVALUATION

1. Visual examination for proper characters, positioning and legibility.

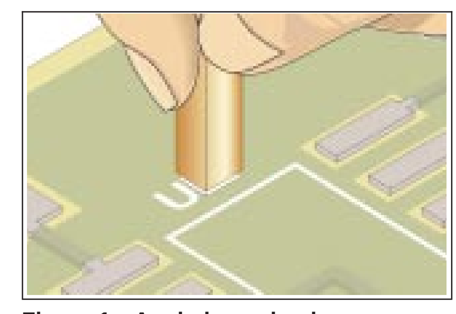


Figure 1 Apply legend using a peg stamp.

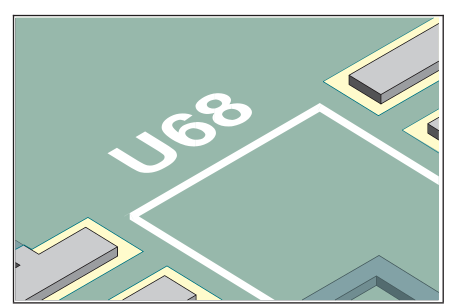


Figure 2 Completed legend repair.

NOTES



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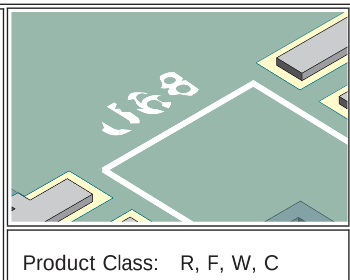
Repair and Modification of Printed Boards and Electronic Assemblies

Revision:

Date: **2/98**

Number: **2.7.2**

Legend/Marking, Hand Lettering Method



Product Class: R, F, W, C

Skill Level: Intermediate

Level of Conformance: High

OUTLINE

This method can be used to add, change or replace legend and markings on printed boards or printed board assemblies. This method uses epoxy ink and a pen to hand letter the legends on the printed board surface.

REFERENCES

2.1 Handling Electronic Assemblies
2.2 Cleaning
2.5 Baking and Preheating
2.6 Epoxy Mixing and Handling

TOOLS & MATERIALS

Cleaner	Knife
Cleaning Wipes	Microscope
Epoxy Ink	Oven
Ink Pen	Wood Stick

PROCEDURE

1. Clean the area.
2. Scrape off any remaining character or legend with a knife and clean the area.

   CAUTION
   Abrasion operations can generate electrostatic charges.
3. Mix the epoxy ink. White is the most common color.
4. Sharpen a wood stick and dip the pointed end into the epoxy ink. Hand letter the legend or markings as needed. (See Figure 1.)
5. Cure the epoxy ink per the manufacturer's instructions.

EVALUATION

1. Visual examination for proper characters, positioning and legibility.

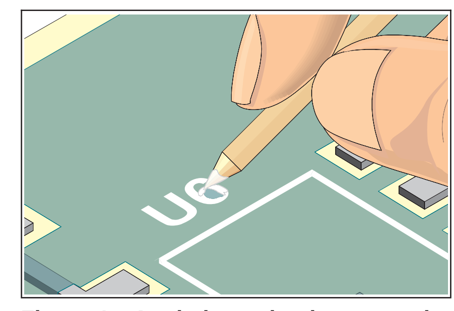


Figure 1 Apply legend using a wood stick dipped in epoxy ink.

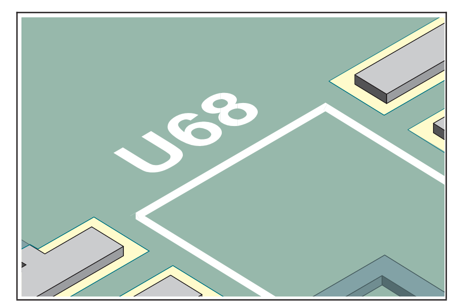


Figure 2 Completed legend repair.

NOTES



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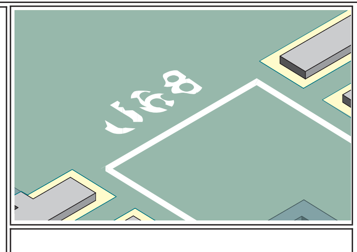
Repair and Modification of Printed Boards and Electronic Assemblies

Revision:

Date: **2/98**

Number: **2.7.3**

Legend/Marking, Stencil Method



Product Class: R, F, W, C

Skill Level: Intermediate

Level of Conformance: High

OUTLINE

This method can be used to add, change or replace legend and markings on printed boards or printed board assemblies. This method uses epoxy ink and a brush or roller technique. A stencil is used to outline the characters.

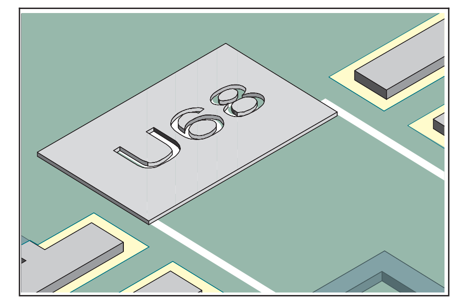


Figure 1 Replace legend using a stencil.

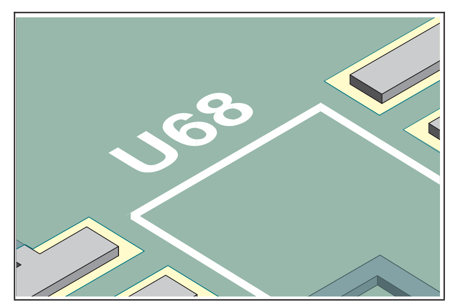


Figure 2 Completed legend repair.

REFERENCES

2.1 Handling Electronic Assemblies
2.2 Cleaning
2.5 Baking and Preheating
2.6 Epoxy Mixing and Handling

TOOLS & MATERIALS

Cleaner	Knife
Cleaning Wipes	Microscope
Epoxy Ink	Oven
Ink Plate	Stencil
Ink Roller	

PROCEDURE

1. Clean the area.
2. Scrape off any remaining character or legend with a knife and clean the area.

   CAUTION
   Abrasion operations can generate electrostatic charges.
3. Select the appropriate stencil or have a special stencil made up. (See Figure 1.)
4. Mix the epoxy ink. White is the most common color. Spread a thin even coating of the epoxy ink on the ink plate or on a smooth surface.
5. Position the stencil on the printed wiring board surface and hold in place firmly.
6 Roll or brush the ink onto the stencil. Do not smudge characters or apply excess ink.
7. Cure the epoxy ink per the manufacturer's instructions.

EVALUATION

1. Visual examination for proper characters, positioning, and legibility.

Number: **2.7.3**	Subject: **Legend/Marking, Stencil Method**
Revision: Date: 2/98	

NOTES



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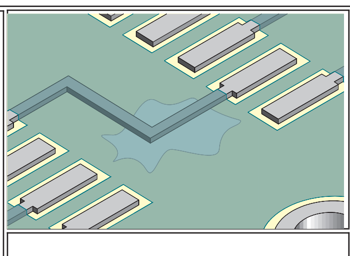
Repair and Modification of Printed Boards and Electronic Assemblies

Revision:

Number: **3.1**

Date: **2/98**

Delamination/Blister Repair, Injection Method



Product Class: R
Skill Level: Advanced
Level of Conformance: High

OUTLINE

This method is used to repair mechanical or thermal blisters or delaminations in printed wiring board laminated base materials. The blister is sealed by injecting a low viscosity epoxy into the blister/delamination void.

CAUTION

This method can only be used when the laminate base material has separated sufficiently to allow the epoxy to flow throughout the void area.

REFERENCES

2.1 Handling Electronic Assemblies
2.2 Cleaning
2.5 Baking and Preheating
2.6 Epoxy Mixing and Handling

TOOLS & MATERIALS

Ball Mill, #1/2
Cleaner
Cleaning Wipes
Epoxy
Epoxy Cartridge with Tip
Epoxy Injection System, Optional
Hand Held Drill
Heat Lamp
Oven
Scraper
Vacuum Source, Optional

PROCEDURE

1. Clean the area.
2. Drill into delamination blister with the dental style drill and ball mill. Drill in an area clear of circuitry or components. Drill at least two holes opposite each other around the perimeter of the delamination. (See Figure 1.) Brush away all loose material.

   CAUTION
   Be careful not to drill too deep exposing internal conductors or planes.

   CAUTION
   Abrasion operations can generate electrostatic charges.
3. Bake the printed wiring board to remove any entrapped moisture. Do not allow the printed wiring board to cool prior to injecting the epoxy.

   CAUTION
   Some components may be sensitive to high temperature.
4. Mix the epoxy. See manufacturers instructions on how to mix epoxy without bubbles.

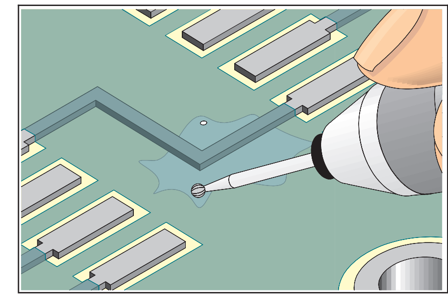


Figure 1 Drill into the delamination blister

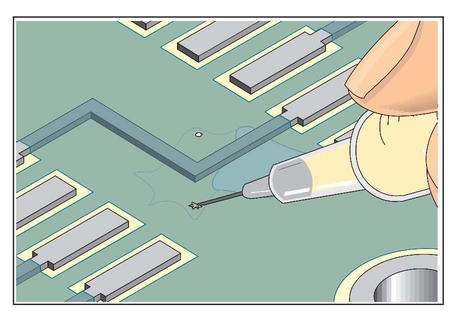


Figure 2 Inject epoxy into the delamination blister.

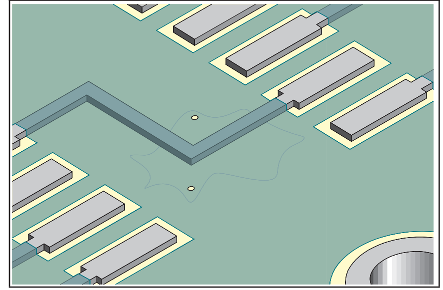


Figure 3 Completed Repair.

CAUTION

Exercise care to prevent bubbles in the epoxy mixture.

5. Pour the epoxy into the epoxy cartridge.
6. Inject the epoxy into one of the holes in the delamination. (See Figure 2.) The heat retained in the printed wiring board will improve the flow characteristics of the epoxy and will draw the epoxy into the void area filling it completely.
7. If the void does not fill completely, the following procedures may be used:
   A. Apply light local pressure on the board surface starting at the fill hole, slowly proceeding to the vent hole.
   B. Apply vacuum to the vent hole to draw the epoxy through the void.
8. Cure the epoxy per the manufacturers recommendation.
9. Scrape away any excess epoxy using a knife or scraper.

NOTE

If needed, apply additional thin coating to seal any scrapped areas.

EVALUATION

1. Visual examination for texture and color match.
2. Electrical tests to conductors around the repaired area as applicable.

NOTES



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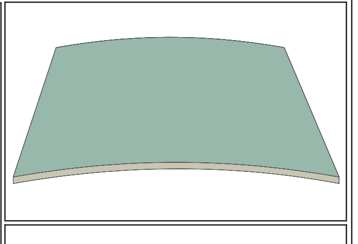
Repair and Modification of Printed Boards and Electronic Assemblies

Revision:

Number: 3.2

Date: 2/98

Bow and Twist Repair



Product Class: R, W
Skill Level: Advanced
Level of Conformance: Medium

OUTLINE

This method is used to eliminate, or reduce the bow and twist, or warping of printed wiring boards. The warping is removed by controlled heating and cooling of the printed wiring board while under restraint.

CAUTION

This repair method is most suitable for FR-4, GE or GF substrate base materials having glass transition temperatures below 125°C. The bake/time cycle will have to be adjusted depending on the base material glass transistion temperature.

CAUTION

This process uses high temperatures. Some components may be sensitive to high temperature and should be removed if this procedure will adversely affect them.

CAUTION

High temperatures will cause oxidation of solderable surfaces.

NOTE

Bow and twist should not be repaired unless sited as a defect.

REFERENCES

2.1 Handling Electronic Assemblies
2.5 Baking and Preheating

TOOLS & MATERIALS

Base Plate
Caliper or Pin Gauges
Oven
Restraint Bars
Restraint Clamps

PROCEDURE

1. Check the deflection to determine if rework is needed. (See Figure 1.)

   NOTE
   Bow and twist after soldering shall not exceed 1.5% for through-hole printed wiring boards and 0.75% for surface mount printed wiring boards. The bow and twist shall not be sufficient to cause difficulties during placement, soldering and testing operations. Before dispositioning printed wiring boards with bow and twist as scrap, keep in mind how the printed wiring board is mounted in it's final destination. Keep in mind ''form, fit and function'' without jeopardizing reliability.

2. Place the restraint bars along the edges that require rework. (See Figure 2.)

   CAUTION
   Components or parts that will interfere with the restraint bars should be removed.

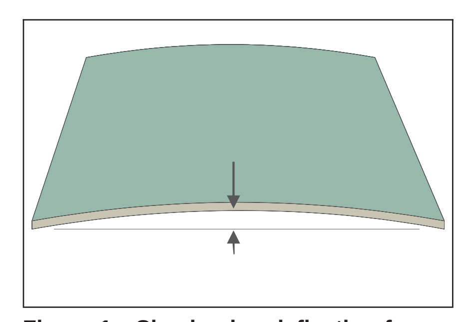


Figure 1 Check edge deflection for maximum wrap.

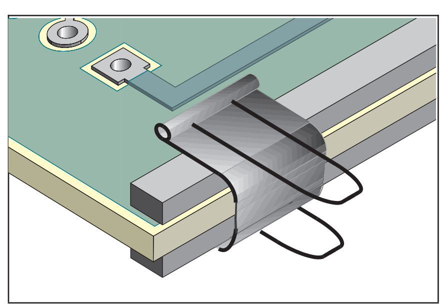


Figure 2 Clamp restraint bars to edge needing rework.

3. If the printed wiring board is warped along more than one edge or more than one plane, clamp the entire printed wiring board to the base plate.
4. Place the printed wiring board, restraint bars and base plate into the oven. Bake for 1 hour at 125°C.

   NOTE
   If possible, after the 1 hour bake cycle, shut off the oven and leave the printed wiring board inside. This will allow the printed wiring board to slowly cool to room temperature improving stress relief.
5. Remove from the oven and allow to cool to room temperature.
6. Remove restraint bars.
7. Check the edges deflection using a caliper or pin gauges.

EVALUATION

1. Check for marks or damage along edges.
2. Electrical tests as applicable.

NOTES



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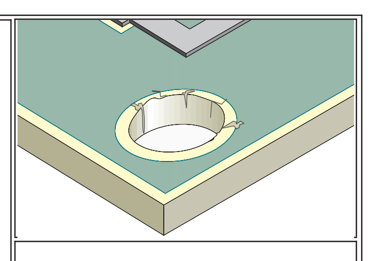
Repair and Modification of Printed Boards and Electronic Assemblies

Revision:

Date: 2/98

Number: 3.3.1

Hole Repair, Epoxy Method



Product Class: R, W
Skill Level: Advanced
Level of Conformance: High

OUTLINE

This method is used to repair cosmetic defects or minor damage to an unsupported tooling or mounting hole. The hole may have component leads, wires, fasteners, pins, terminals or other hardware run through it. This repair method uses high strength epoxy to restore the damaged surface surrounding the hole. This method can be used on single sided, double sided or multilayer printed wiring boards and assemblies.

CAUTION

Damaged inner-layer connections may require surface wire adds.

REFERENCES

2.1 Handling Electronic Assemblies
2.2 Cleaning
2.5 Baking and Preheating
2.6 Epoxy Mixing and Handling

TOOLS & MATERIALS

Ball Mills
Cleaner
Color Agent, Various Colors
Epoxy
Hand Held Drill
Polyimide Tape
Knife
Mixing Sticks
Oven
Wipes

PROCEDURE

1. Clean the area.
2. Mill away the damaged board base material using the hand held drill and ball mill. All damaged base board material and solder resist must be removed. No fibers of laminate material should be exposed at the surface peremiter of the hole. (See Figure 1.)

   NOTE
   To clearly see that all damaged material has been removed, flood the area with alcohol or solvent. Damaged internal fibers of the base material will show up clearly.
3. Remove all loose material and clean the area.
4. Where needed, apply Polyimide tape to protect exposed parts of the printed wiring board. Tape may be required inside the hole. If epoxy reduces the inside diameter, the hole may have to be redrilled after the epoxy has cured.

   NOTE
   The printed wiring board may be preheated prior to filling the area with epoxy. A preheated printed wiring board will allow the epoxy to easily flow and level out.

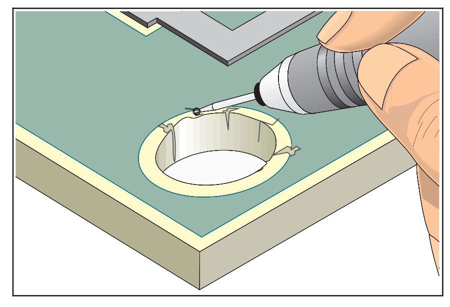


Figure 1 Mill away damaged material.

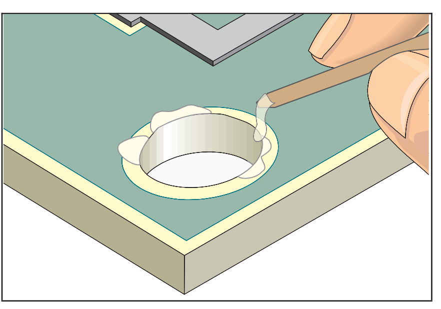


Figure 2 Apply epoxy with a small wood stick sharpened at one end.

Number: **3.3.1**	Subject: **Hole Repair, Epoxy Method**
Revision: Date: 2/98	

Epoxy applied to an unheated printed wiring board may settle below the printed wiring board surface as the epoxy cures.

CAUTION

Some components may be sensitive to high temperatures.

5. Mix the epoxy. If desired, add color agent to the mixed epoxy to match the printed wiring board color.
6. Coat the area with epoxy up to and flush with the printed wiring board surface. A small wood stick may be used to apply and spread the epoxy. (See Figure 2.)

   NOTE

   A slight overfill of epoxy may be desired to allow for shrinkage when epoxy cures.
7. Cure epoxy per the manufacturers recommended instructions.
8. After the epoxy has cured, remove the tape.
9. If needed, use the knife or scraper and scrape off any excess epoxy. Scrape until the new epoxy surface is level with the surrounding printed wiring board surface.

   NOTE

   Apply surface coating to match prior coating as required.
10. Remove all loose material. Clean the area.

EVALUATION

1. Visual examination for texture and color match.
2. Hole size measurement to specification
3. Electrical tests to conductors around the repaired area as applicable.

NOTES



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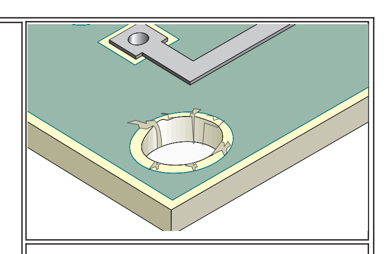
Repair and Modification of Printed Boards and Electronic Assemblies

Revision:

Date: **2/98**

Number: **3.3.2**

Hole Repair, Transplant Method



Product Class: R, W
Skill Level: Expert
Level of Conformance: High

OUTLINE

This method is used to repair severe damage to a hole or to modify the size, shape or location of an unsupported tooling or mounting hole. The hole may have component leads, wires, fasteners, pins, terminals or other hardware run through it. This repair method uses a dowel of matching board material and high strength epoxy to secure the dowel in place. After the new material is bonded in place a new hole can be drilled. This method can be used on single sided, double sided or multilayer printed wiring boards and assemblies.

CAUTION

Damaged inner-layer connections may require surface wire adds.

REFERENCES

2.1 Handling Electronic Assemblies
2.2 Cleaning
2.5 Baking and Preheating
2.6 Epoxy Mixing and Handling

TOOLS & MATERIALS

Base Material Rod,
  Various Diameters
Cleaner
Epoxy
Hand Held Drill
Polyimide Tape
Knife
Microscope
Mixing Sticks
Oven
Precision Drill Press
Razor Saw
Wipes

PROCEDURE

1. Clean the area.
2. Drill out the damaged or improperly sized hole using a carbide end mill or drill. Mill the hole using a precision drill press or milling machine for accuracy. The diameter of the cutting tool should be as small as possible yet still encompass the entire damaged area. (See Figures 1 and 2.)

   NOTE
   Abrasion operations can generate electrostatic charges.
3. Cut a piece of replacement base material rod. Base material rod is made from FR-4 dowel stock. Cut the length approximately 12.0 mm longer than needed.
4. Clean the reworked area.
5. Use Polyimide tape to protect exposed parts of the printed wiring board bordering the rework area.
6. Mix the epoxy.

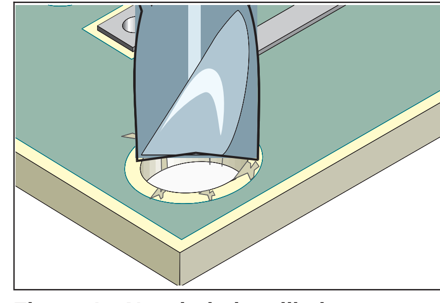


Figure 1 New hole is milled to encompass entire damaged area.



Figure 2 Precision drill press with microscope attachment.

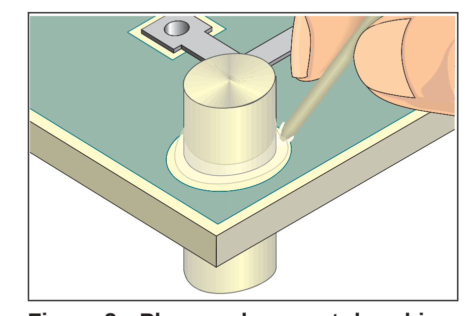


Figure 3 Place replacement dowel in position and bond with epoxy.

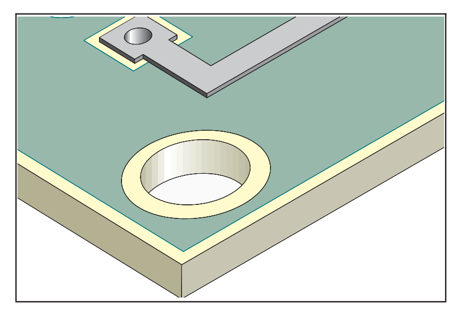


Figure 4 Cut off excess material and redrill holes as required.

7. Coat both the dowel and the hole with epoxy and fit together. Apply additional epoxy around perimeter of new material. (See Figure 3.) Remove excess epoxy.
8. Cure the epoxy per the manufactures instructions.

   CAUTION

   Some components may be sensitive to high temperatures.
9. Remove tape and cut off the excess material using the razor saw. Mill or file the dowel flush with the board surface.
10. Complete the procedure by redrilling holes and adding circuitry as required. (See Figure 4.)

    NOTE

    Apply surface coating to match prior coating as required.
11. Clean the reworked area.

EVALUATION

1. Visual and dimensional examination of the reworked area for conformance to drawings and specifications.

NOTES



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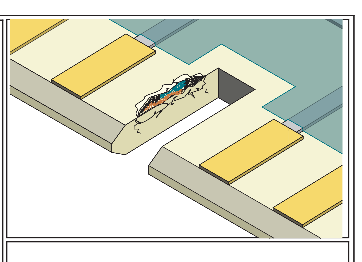
Repair and Modification of Printed Boards and Electronic Assemblies

Revision:

Date: **2/98**

Number: **3.4.1**

Key and Slot Repair, Epoxy Method



Product Class: R, W
Skill Level: Advanced
Level of Conformance: High

OUTLINE

This method is used to repair minor damage to a key slot, or other cutout in a printed board or assembly. The area is repaired using high strength epoxy.

CAUTION

Care should be taken to limit the application of epoxy to the specific areas desired and to avoid damage to the conductive patterns, contacts and components.

REFERENCES

2.1 Handling Electronic Assemblies
2.2 Cleaning
2.5 Baking and Preheating
2.6 Epoxy Mixing and Handling

TOOLS & MATERIALS

Cleaner
Cleaning Wipes
Color Agent, Various Colors
Epoxy
Hand Held Drill
Polyimide Tape
Knife
Milling Machine
Mixing Sticks
Oven
Precision Drill Press
Scraper

PROCEDURE

1. Clean the area to be filled, including the edges.
2. Mill away the damaged board base material using a hand held drill and ball mill. All damaged base board material must be removed. No fibers of laminate material should be exposed at the surface of the keyslot. (See Figure 1.)

   NOTE
   To clearly see that all damaged material has been removed, flood the area with alcohol or solvent. Damaged internal fibers of the base material will show up clearly.

   CAUTION
   Abrasion operations can generate electrostatic charges.
3. Remove all loose material and clean the area.
4. Apply Polyimide tape to the surface of the printed wiring board adjacent to the slot. The tape should protect any adjacent contacts or components.

   NOTE
   The printed wiring board may be preheated prior to filling the area with epoxy. A preheated printed wiring board will allow the epoxy to easily flow and level out. Epoxy applied to an unheated printed wiring board may settle below the printed wiring board surface as the epoxy cures.

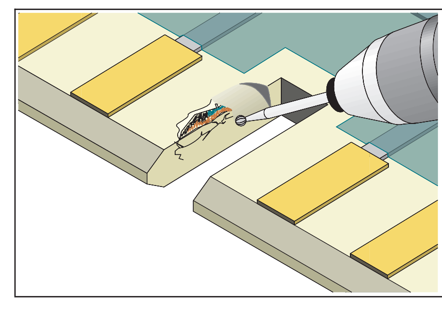


Figure 1 Mill away the damaged board base material.

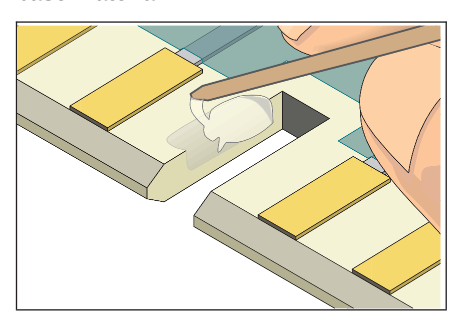


Figure 2 Apply epoxy to the edges of the key slot.

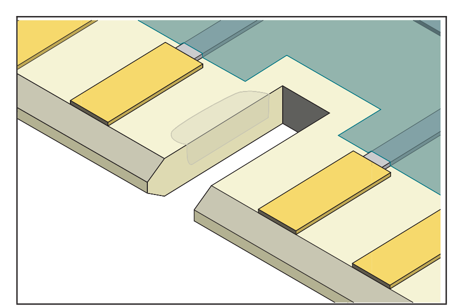


Figure 3 Complete key slot repair.

5. Mix the epoxy. If desired, add color agent to the mixed epoxy to match the printed wiring board color.
6. Apply a small amount of epoxy to the edges of the slot. A mixing stick sharpened at the end may be used to apply the epoxy. (See Figure 2.)

   NOTE
   A slight overfill of epoxy may be desired to allow for shrinkage when epoxy cures.

   NOTE
   The printed wiring board may be turned on its side to keep the epoxy in place while it cures.
7. Cure the epoxy per the manufacturers instructions.

   CAUTION
   Some components may be sensitive to high temperature.
8. After the epoxy has cured remove the tape.
9. If needed use the knife or scraper and scrape off any excess epoxy.
10. If precision is required, machine the edges of the slot using a milling machine or precision drill and appropriate milling cutter. Use great care to correctly relocate the slot.

    NOTE
    If needed, apply additional thin coating to seal any scrapped areas.
11. Clean the area.

EVALUATION

1. Visual examination and measurement of key slot location and dimension.

NOTES



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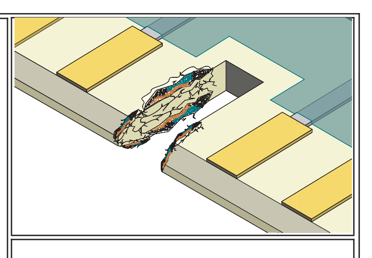
Repair and Modification of Printed Boards and Electronic Assemblies

Revision:

Date: **2/98**

Number: **3.4.2**

Key and Slot Repair, Transplant Method



Product Class: R, W

Skill Level: Expert

Level of Conformance: High

OUTLINE

This method is used to modify or repair a key slot, or other cutout in a printed board or assembly. A replacement piece of matching board material is epoxied into the area needing repair. A new cut is then machined into the repaired area if needed.

CAUTION

Care should be taken to limit the application of epoxy to the specific areas desired and to avoid damage to the conductive patterns, contacts and components.

REFERENCES

2.1 Handling Electronic Assemblies
2.2 Cleaning
2.5 Baking and Preheating
2.6 Epoxy Mixing and Handling

TOOLS & MATERIALS

Ball Mills, Carbide
Base Material, Various Sizes
Carbide Saw
Cleaner
Cleaning Wipes
Epoxy
End Mills
Hand Held Drill
Polyimide Tape
Knife
Milling Machine
Mixing Stick
Oven
Precision Drill Press
Scraper

PROCEDURE

1. Clean the area to be filled, including the edges.
2. Mill out the damaged area using a milling machine or precision drill system and carbide end mill. (See Figure 1.)

   CAUTION
   Abrasion operations can generate electrostatic charges.
3. Clean the area.
4. Install carbide saw into the hand held drill. Set the speed to maximum and machine a groove in the edge of the printed wiring board where the new base material will be installed. The groove must be centered in the edge to ensure that the new piece will fit properly. The groove width should be approximately 1/3 of the printed wiring board thickness. The groove depth should be be approximately double the groove width. (See Figure 2.)
5. Cut a piece of replacement base board material that is the same thickness and type as the printed wiring board. The replacement piece should be longer than the length of the slot to allow for ease of handling.

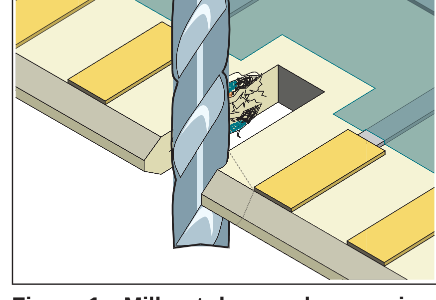


Figure 1 Mill out damaged area using a carbide end mill.

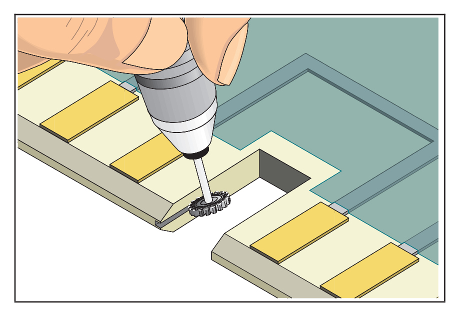


Figure 2 Cut a groove into both sides of the key slot.

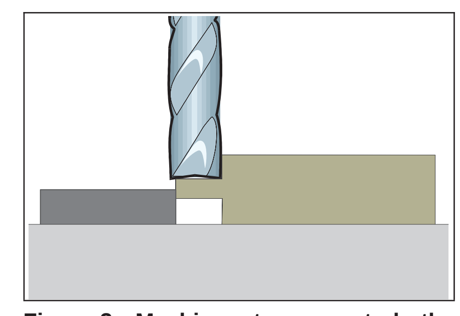


Figure 3 Machine a tongue onto both sides of replacement material.

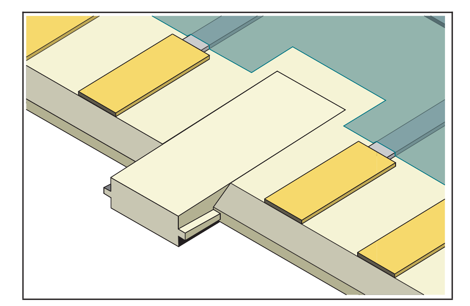


Figure 4 Insert the replacement piece into the slot.

6. Install an end mill into the chuck of the drill press. Machine a tongue onto both sides of the replacement piece. The dimensions of the tongue should match the size of the milled groove. (See Figure 3.)
7. Where required apply tape to protect exposed parts of printed wiring board bordering the prepared area.
8. Carefully check the fit of the replacement piece and then clean both the replacement piece and the slot. The replacement base material should fit firmly into the slot so that it will not move or fall out when epoxied in place.
9. Apply tape to the surface of the printed wiring board adjacent to the slot. The tape should protect any adjacent contacts or components.
10. Mix the epoxy.
11. Apply a small amount of epoxy to the edges of the replacement piece and to the inside edges of the slot.
12. Insert the replacement piece into the slot. Check alignment. Remove excess epoxy. (See Figure 4.)
13. If needed, apply additional epoxy to the edges of the slot. A wood stick sharpened at the end may be used to apply the epoxy.
14. Cure the epoxy per the manufacturers instructions.

    CAUTION

    Some components may be sensitive to high temperature.
15. After the epoxy has cured remove the tape.
16. If needed use the knife or scraper and scrape off any excess epoxy.

    NOTE

    If needed, apply additional thin coating to seal any scrapped areas.
17. Clean the area.
18. Cut off excess length of replacement material and file to match contour of existing edge. (See Figure 5.)
19. If a new slot is needed, machine using milling machine and appropriate milling cutter. Use great care to correctly relocate the slot.
20. Clean the area.

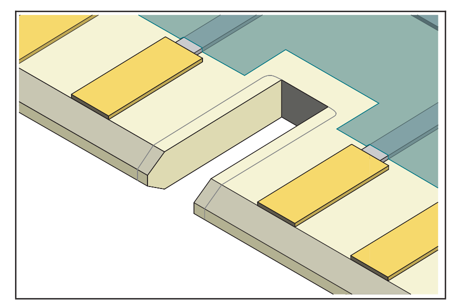


Figure 5 Cut off excess material and file to match edge.

EVALUATION

1. Visual examination and measurement of key slot location and dimension.

NOTES



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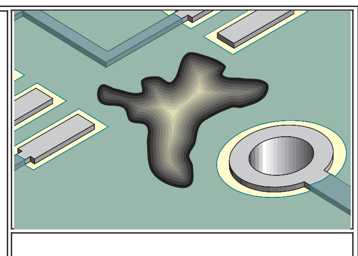
Repair and Modification of Printed Boards and Electronic Assemblies

Revision:

Date: **2/98**

Number: **3.5.1**

Base Material Repair, Epoxy Method



Product Class: R, W
Skill Level: Advanced
Level of Conformance: High

OUTLINE

This procedure is used to repair minor damage to printed wiring board base material. Scrapes and scratches in the board base material may be caused by accidents during handling. Burns in the base material may be caused by improper use of soldering and desoldering tools.

CAUTION

This method may be used when the damage extends deep into the base material, but not completely through. If the base board material is damaged completely through, see Procedure No. 3.5.2 or 3.5.3.

CAUTION

Surface conductors may need to be replaced in the damaged area. Be sure that the appropriate conductor diagrams, or photographs reflecting the original conductors are available so that they may be replaced after repairing the base board material. Damage to internal conductors or planes may have to be restored using surface wires.

REFERENCES

2.1 Handling Electronic Assemblies
2.2 Cleaning
2.5 Baking and Preheating
2.6 Epoxy Mixing and Handling

TOOLS & MATERIALS

Ball Mills, Carbide	Hand Held Drill	Microscope
Cleaner	Halogen Light	Oven
Color Agent, Various Colors	Heat Lamp	Scraper
	Polyimide Tape	Wipes
Epoxy	Knife	

PROCEDURE

1. Clean the damaged area.
2. Scrape away the damaged board base material using a knife.
   All damaged base board material and solder resist must be removed at the surface. (See Figure 1.) See step 2A for alternate method.

   NOTE
   To clearly see that all damaged material has been removed, flood the area with alcohol or solvent. Damaged internal fibers of the base material will show up clearly.

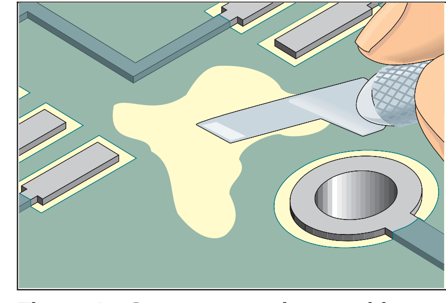


Figure 1 Scrape away damaged base board material with a knife.

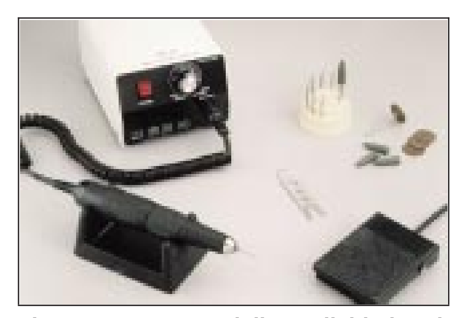


Figure 2 Commercially available hand held drill.

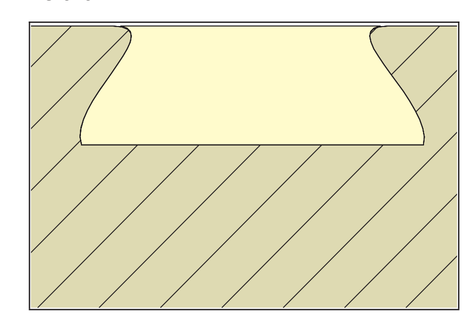


Figure 3 An undercut to enhance mechanical strength.

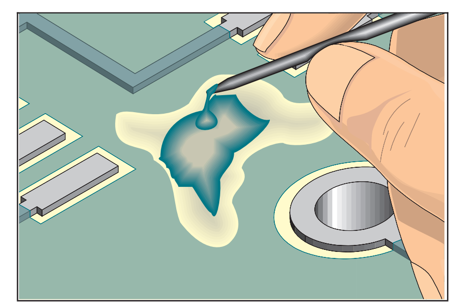


Figure 4 Apply the epoxy with a wood stick sharpened at the end.

CAUTION
Abrasion operations can generate electrostatic charges.

2A. Mill away the damaged board base material using dental style drill and ball mill. All damaged base board material and solder resist must be removed. (See Figure 2.)

NOTE
An undercut to enhance mechanical strength may be desired for class 3 product. (See Figure 3.)

3. Remove all loose material and clean the area.
4. Where needed, apply tape to protect exposed parts of printed wiring board.

NOTE
The printed wiring board may be preheated prior to filling the area with epoxy. A preheated printed wiring board will allow the epoxy to easily flow and level out. Epoxy applied to an unheated printed wiring board may settle below the printed wiring board surface as the epoxy cures.

5. Mix the epoxy. If desired, add color agent to the mixed epoxy to match the printed wiring board color.
6. Fill the area with epoxy up to and flush with the printed wiring board surface. No fibers of laminate material should be exposed. A wood stick sharpened at the end may be used to apply and spread the epoxy. For large areas, apply the epoxy with a foam swab to create a texture in the surface. (See Figures 4 and 5.)

NOTE
A slight overfill of epoxy may be desired to allow for shrinkage when epoxy cures.

NOTE
Epoxy may be applied using a foam swab to restore the surface appearance.

7. Cure the epoxy per the manufacturer's instructions.

CAUTION
Some components may be sensitive to high temperature.

8. After the epoxy has cured remove the tape.
9. If needed, use a knife or scraper and scrape off any excess epoxy. Scrape until the new epoxy surface is level with the surrounding printed wiring board surface.
10. Remove all loose material. Clean the area.

NOTE
If needed, apply an additional thin coating to seal any scraped areas.

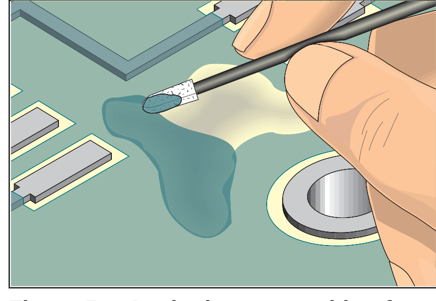


Figure 5 Apply the epoxy with a foam swab to create a texture in the surface.

EVALUATION

1. Visual examination for texture and color match.
2. Electrical tests to conductors around the repaired area as applicable.

NOTES



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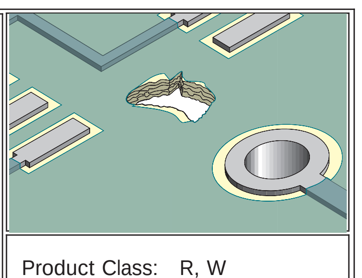
Repair and Modification of Printed Boards and Electronic Assemblies

Revision:

Date: **2/98**

Number: **3.5.2**

Base Material Repair, Area Transplant Method



Product Class: R, W

Skill Level: Expert

Level of Conformance: High

OUTLINE

This procedure is used to repair mechanical or thermal damage to printed wiring board base material. This method is used when extended areas of base material must be completely replaced. This method may be used on single sided, double sided or multilayer printed wiring boards or assemblies.

CAUTION

Surface conductors may need to be replaced in the damaged area. Be sure that the appropriate conductor diagrams, or photographs reflecting the original conductors are available so that they may be replaced after repairing the base board material. Damage to internal conductors or planes may have to be restored using surface wires.

REFERENCES

2.1 Handling Electronic Assemblies
2.2 Cleaning
2.5 Baking and Preheating
2.6 Epoxy Mixing and Handling

TOOLS & MATERIALS

Ball Mills, Carbide	Hand Held Drill
Base Board Material	Heat Lamp
Carbide Saw	Polyimide Tape
Cleaner	Knife
Cleaning Wipes	Oven
Color Agent, Various Colors	Precision Drill Press
End Mills, Carbide	Razor Saw
Epoxy	Scraper

PROCEDURE

1. Clean the area
2. Mill away the damaged board material using a hand held drill and ball mill. Remove all evidence of the damaged material. No fibers of laminate material should be exposed. At the surface file the edges to ensure that the opening is rectangular or uniform in shape. (See Figure 1.)

   CAUTION

   Abrasion operations can generate electrostatic charges.
3. Clean the area.

   3A. Bevel the edge using a hand held drill and ball mill or using a file. (See Figure 2.)

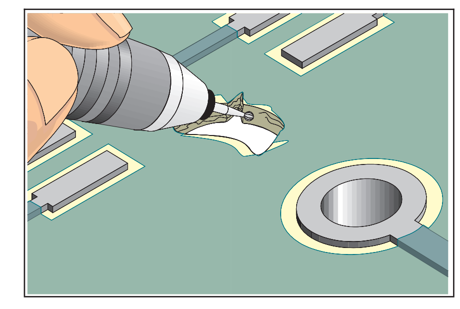


Figure 1 Mill away damaged base material.

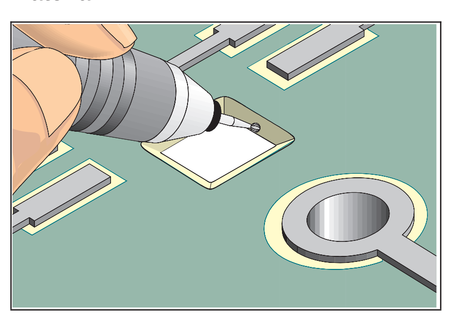


Figure 2 Bevel edge using a hand held drill or file.

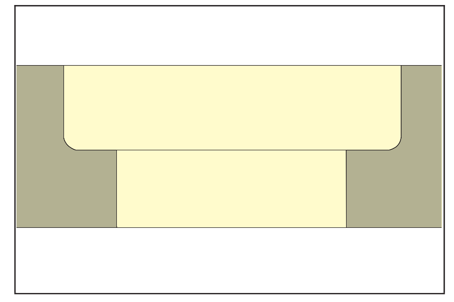


Figure 3 Mill a step into the edge of the PC board.

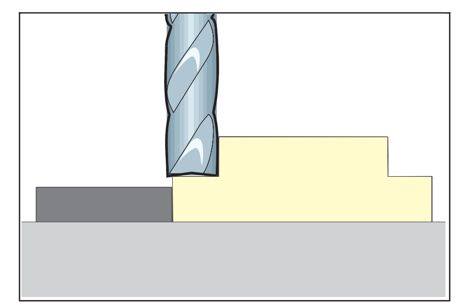


Figure 4 Mill a step onto the edge of the replacement base material.

CAUTION
Exercise care to avoid damage to any internal conductors. If any internal conductors are damaged, surface wires may be required to restore electrical connection.

3B. Install an end mill into the chuck of a precision drill press. Set the speed to maximum and machine a step or lap joint in the edge of the printed wiring board where the new base material will be installed. The depth and width of the step should be approximately 1/2 of the printed wiring board thickness. (See Figure 3.)

4. Cut or machine a piece of replacement base board material that is the same thickness and type as the piece removed. The replacement piece must be precisely the same size and shape of the opening including the step joint.
5. Install an end mill into the chuck of a precision drill press. Machine a step onto the entire mating edge of the replacement base material. The dimensions of the step should match the size of the step in the printed wiring boardmilled groove. (See Figure 4.)
6. Where required apply Polyimide tape to protect exposed parts of printed wiring board bordering the prepared area.
7. Check the fit to be sure the new base material properly mates with the step in the printed wiring board.
8. Mix the epoxy.
9. Coat both the tongue and groove surfaces with epoxy and fit together. (See Figure 5.) Remove excess epoxy.
10. Cure the epoxy per the manufacturers instructions.

    CAUTION
    Some components may be sensitive to high temperature.
11. After the epoxy has cured remove the Polyimide tape.
12. If needed scrape off any excess epoxy using a scraper or knife.

    NOTE
    If needed, apply additional thin coating to seal any scrapped areas.
13. Clean the area.
14. Complete by drilling holes, slots, etc. or adding circuitry as required.
15. If solder resist replacement or conformal coating is needed see appropriate procedure.

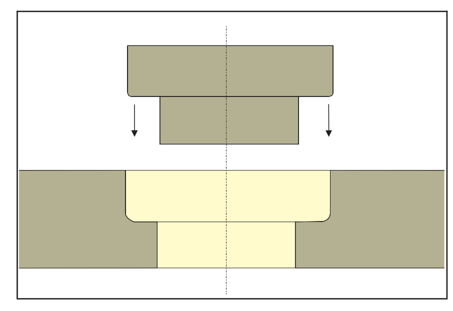


Figure 5 Bond replacement piece in place.

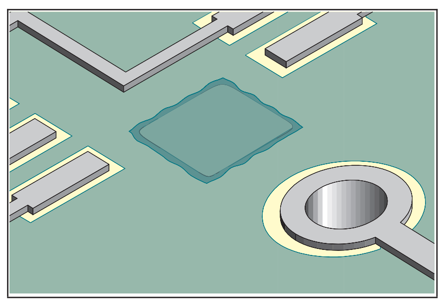


Figure 6 Completed repair.

EVALUATION

1. Dimensions of area replaced should be checked to conform to specifications required.

NOTES



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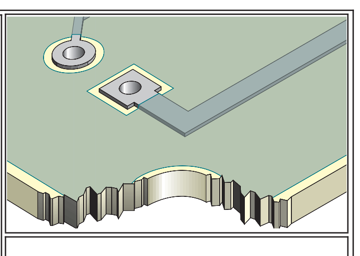
Repair and Modification of Printed Boards and Electronic Assemblies

Revision:

Date: **2/98**

Number: **3.5.3**

Base Material Repair, Edge Transplant Method



Product Class: R, W

Skill Level: Expert

Level of Conformance: High

OUTLINE

This procedure is used to repair mechanical or thermal damage to printed wiring board base material. This method is used when extended areas of base material must be completely replaced. This method may be used on single sided, double sided or multilayer printed wiring boards or assemblies.

CAUTION

Surface conductors may need to be replaced in the damaged area. Be sure that the appropriate conductor diagrams, or photographs reflecting the original conductors are available so that they may be replaced after repairing the base board material. Damage to internal conductors or planes may have to be restored using surface wires.

REFERENCES

2.1 Handling Electronic Assemblies
2.2 Cleaning
2.5 Baking and Preheating
2.6 Epoxy Mixing and Handling

TOOLS & MATERIALS

Ball Mills, Carbide
Base Board Material
Carbide Saw
Cleaner
Cleaning Wipes
Color Agent, Various Colors
End Mills, Carbide
Epoxy
Hand Held Drill
Heat Lamp
Polyimide Tape
Knife
Oven
Precision Drill Press
Razor Saw
Scraper

PROCEDURE

1. Clean the area
2. Cut away the damaged board material using a razor saw or milling cutter. Remove all evidence of the damaged material. No fibers of laminate material should be exposed. File the edge to ensure that the edge is flat. (See Figure 1.)

   CAUTION
   Abrasion operations can generate electrostatic charges.

   CAUTION
   Exercise care to avoid damage to any internal conductors. If any internal conductors are damaged, surface wires may be required to restore electrical connection.
3. Clean the area.

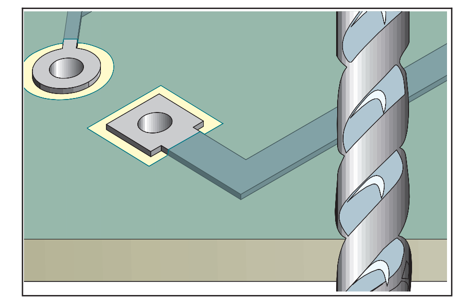


Figure 1 Cut away damaged base material.

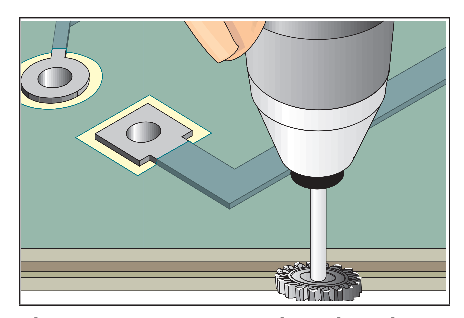


Figure 2 Cut a groove into the edge of the PC board.

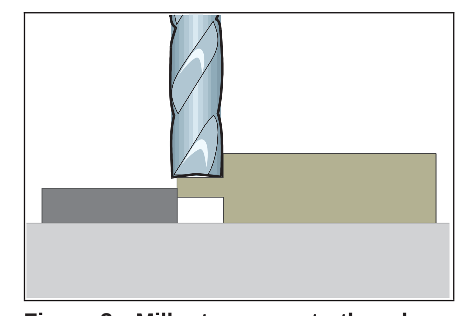


Figure 3 Mill a tongue onto the edge of the replacement base material.

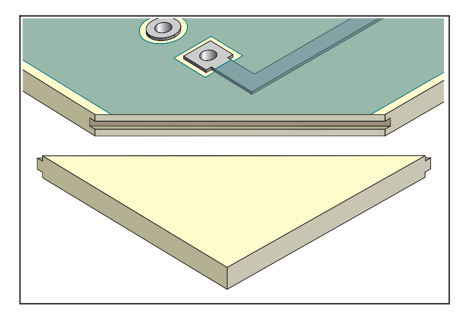


Figure 4 Check fit of new base material.

4. Install a carbide saw into the hand held drill. Set the speed to maximum and machine a groove in the edge of the printed wiring board where the new base material will be installed. The groove must be centered in the edge to ensure that the new piece will fit properly. The groove width should be approximately 1/3 of the printed wiring board thickness. The groove depth should be approximately double the groove width. (See Figure 2.)
5. Cut a piece of replacement base board material that is the same thickness and type as the piece removed. The replacement piece may be oversized, the excess material will be removed after the replacement piece has been epoxied in place.
6. Install an end mill into the chuck of a precision drill press. Machine a tongue onto the entire mating edge of the replacement base material. The dimensions of the tongue should match the size of the milled groove. (See Figure 3.)
7. Where required apply Polyimide tape to protect exposed parts of printed wiring board bordering the prepared area.
8. Check the fit to be sure the new base material properly mates with the groove in the printed wiring board. (See Figure 4.)
9. Mix the epoxy.
10. Coat both the tongue and groove surfaces with epoxy and fit together. Remove excess epoxy.
11. Cure the epoxy per the manufacturers instructions.

    CAUTION

    Some components may be sensitive to high temperature.
12. After the epoxy has cured remove the Polyimide tape.
13. If needed, scrape off any excess epoxy using a scraper or knife.

    NOTE

    If needed, apply additional thin coating to seal any scrapped areas.
14. Saw or mill off excess base material and file flush with existing edge. (See Figure 5.)
15. Clean the area.
16. Complete by drilling holes, slots, etc. or adding circuitry as required. (See Figure 6.)
17. If needed, replace solder resist or conformal coating.

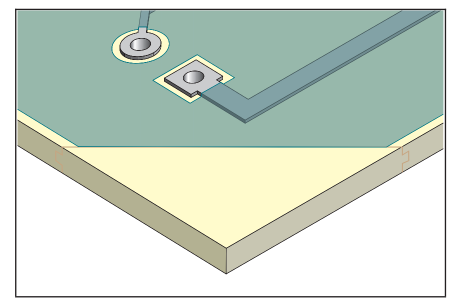


Figure 5 Saw off excess new base material.

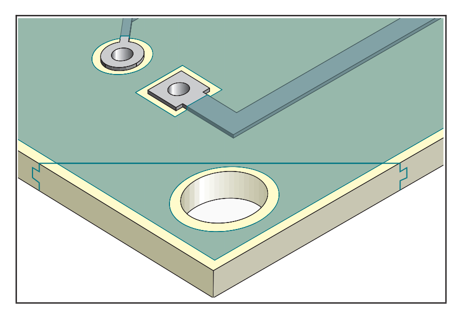


Figure 6 Complete by drilling holes, or adding circuitry as required.

EVALUATION

1. Dimensions of area replaced should be checked to conform to specifications required.

NOTES



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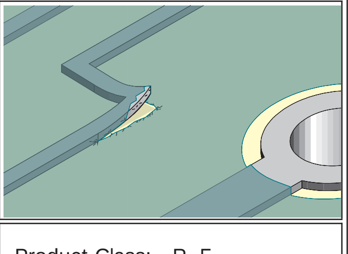
Repair and Modification of Printed Boards and Electronic Assemblies

Revision:

Date: **2/98**

Number: **4.1.1**

Lifted Conductor Repair, Epoxy Seal Method



Product Class: R, F
Skill Level: Intermediated
Level of Conformance: Medium

OUTLINE

This method is used to rebond a lifted conductor. Liquid epoxy is inserted under and around the conductor to bond it back down to the printed wiring board surface.

CAUTION

This method should not be used to rebond a conductor that has been stretched or damaged.

REFERENCES

2.1 Handling Electronic Assemblies
2.2 Cleaning
2.5 Baking and Preheating
2.6 Epoxy Mixing and Handling

TOOLS AND MATERIALS

Cleaner	Heat Lamp or Oven
Cleaning Wipes	Knife
Epoxy	Pick

PROCEDURE

1. Clean the area.
2. Remove any obstructions that prevent the lifted conductor from making contact with the base board surface.

   CAUTION
   Be careful while cleaning and removing all obstructions, not to stretch or damage the lifted conductor.
3. Clean the area.
4. Mix the epoxy.
5. Carefully apply a small amount of epoxy under the entire length of the lifted conductor. The tip of a knife may be used to apply the epoxy. (See Figure 1.)
6. Press the lifted conductor down into the epoxy and into contact with the base board material.
7. Apply additional epoxy to the surface of the lifted conductor and to all sides as needed.
8. Cure the epoxy per the manufacturer's instructions.

   CAUTION
   Some components may be sensitive to high temperature.
9. Apply surface coating to match prior coating as required.

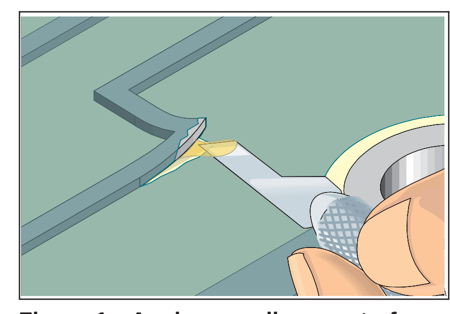


Figure 1 Apply a small amount of epoxy under the lifted conductor.

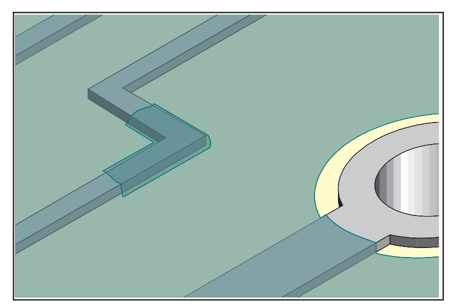


Figure 2 Completed repair.

Number: 4.1.1	Subject: Lifted Conductor Repair, Epoxy Seal Method
Revision: Date: 2/98	

EVALUATION

1. Visual examination and tape test per IPC-TM-650, Test Method 2.4.1.
2. Electrical tests as applicable.

NOTES



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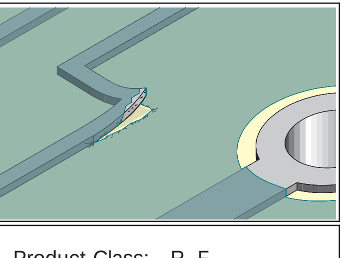
Repair and Modification of Printed Boards and Electronic Assemblies

Revision:

Date: **2/98**

Number: **4.1.2**

Lifted Conductor Repair, Film Adhesive Method



Product Class: R, F
Skill Level: Intermediate
Level of Conformance: High

OUTLINE

This method is used to re-bond a lifted conductor. Dry film epoxy is used to re-bond the lifted conductor.

CAUTION

This method should not be used to re-bond a conductor that has been stretched or damaged

REFERENCES

2.1 Handling Electronic Assemblies
2.2 Cleaning
2.5 Baking and Preheating

TOOLS & MATERIALS

Bonding Iron
Bonding System
Bonding Tips
Cleaner
Cleaner Wipes
Dry Film Epoxy
Polyimide Tape
Knife
Microscope
Scraper
Tweezers

PROCEDURE

1. Clean the area.
2. Remove any obstructions that prevent the lifted conductor from making contact with the base board surface.

   CAUTION
   Be careful while cleaning and removing all obstructions, not to stretch or damage the lifted conductor.
3. Clean the area.
4. Cut out a piece of dry film epoxy that closely matches the size of the lifted conductor. Be careful not to contaminate the dry film epoxy with materials that could reduce the bond strength. (See Figure 1.)

   NOTE
   Dry film epoxy thickness should be selected to meet the requirements of the printed wiring board.
5. Place a piece of Polyimide tape over the lifted conductor. Leave the tape in place during the bonding cycle. (See Figure 2.)
6. Position the printed wiring board so that it is flat and stable. Gently place the hot bonding tip onto the tape covering the conductor. Apply pressure and heat per equipment manufacturer's recommendation. (See Figure 3.)

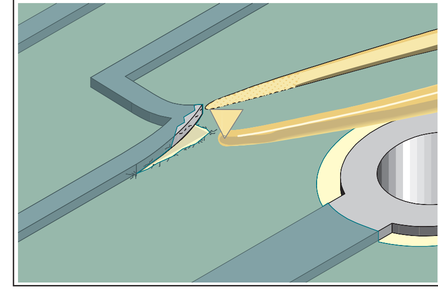


Figure 1 Place a piece of dry film epoxy under lifted conductor.

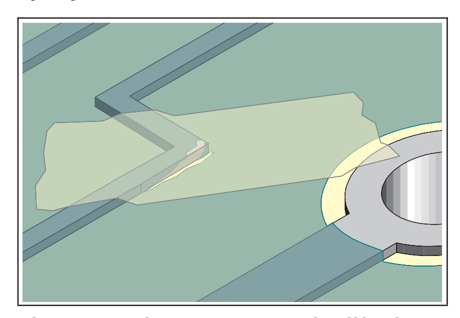


Figure 2 Place tape over the lifted conductor.



Figure 3 Bond the lifted conductor using a bonding system.

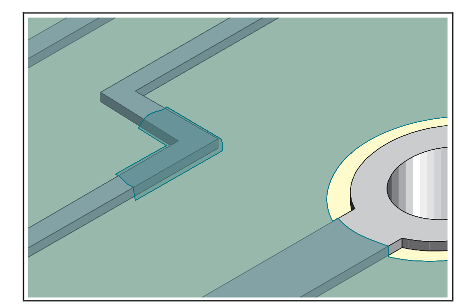


Figure 4 Completed repair.

NOTE
The bonding tip should be as small as possible but should completely cover the entire surface of the conductor.

7. After the bonding cycle lift the bonding tool and remove the tape used for alignment. The film is fully cured. Carefully clean the area and inspect the conductor.
8. Replace surface coating to match prior coating as required.

EVALUATION

1. Visual examination and tape test per IPC-TM-650, Test Method 2.4.1.
2. Electrical tests as applicable.

NOTES



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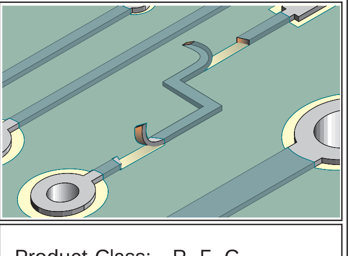
Repair and Modification of Printed Boards and Electronic Assemblies

Revision: A

Date: 11/99

Number: **4.2.1**

Conductor Repair, Foil Jumper, Epoxy Method



Product Class: R, F, C

Skill Level: Advanced

Level of Conformance: Medium

OUTLINE

This method is used on printed wiring boards to replace damaged or missing conductors on the printed wiring board surface.

CAUTION

The conductor widths, spacing and current carrying capacity must not be reduced below allowable tolerances.

REFERENCES

2.1 Handling Electronic Assemblies
2.2 Cleaning
2.5 Baking and Preheating
2.6 Epoxy Mixing and Handling

TOOLS AND MATERIALS

Buffer	Light
Cleaner	Liquid Flux
Conductor Foil Jumpers	Microscope
Color Agent	Oven
Various Colors	Scraper
Epoxy	Solder
Hand Held Drill	Solder Iron with Tips
Heat Lamp	Wipes
Polyimide Tape	
Knife	

PROCEDURE

1. Clean the area.
2 Remove the damaged section of conductor using a knife. The damaged conductor should be trimmed back to a point where the conductor still has a good bond to the printed wiring board surface.

   NOTE
   Heat can be applied to the damaged conductor using a soldering iron to allow the conductor to be removed more easily.
3. Use a knife and scrape off any solder resist or coating from the ends of the remaining conductor. (See Figure 1.)
4. Remove all loose material. Clean the area.

   NOTE
   It is essential that the board surface be smooth and flat. If the base material is damaged see appropriate procedure.

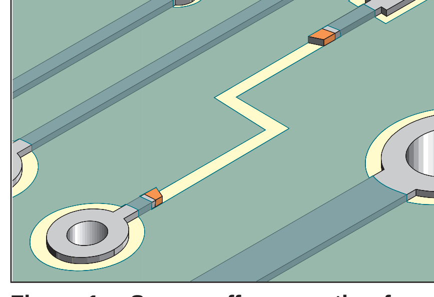


Figure 1 Scrape off any coating from the ends of the remaining conductors.

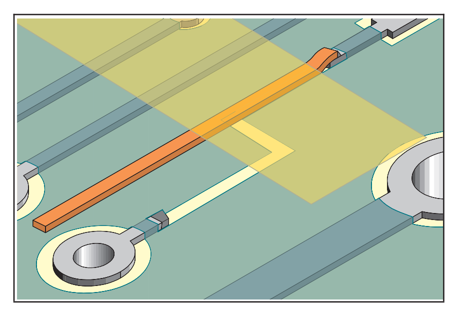


Figure 2 Place the new foil jumper in position, hold in place with tape conductor.

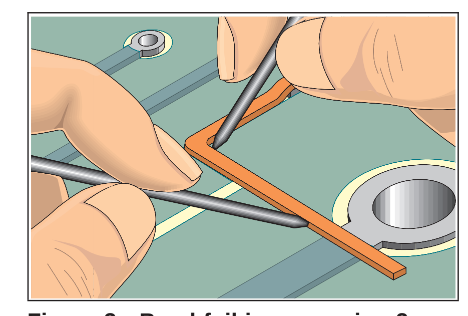


Figure 3 Bend foil jumper using 2 wood sticks.

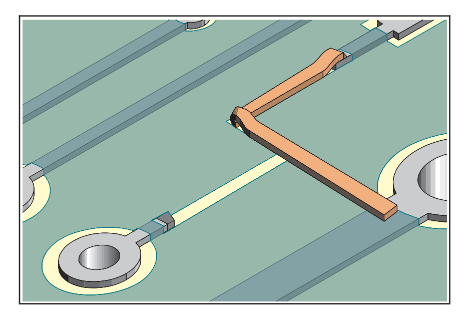


Figure 4 Wide conductors may be folded over.

5. Apply a small amount of liquid flux to the ends of the remaining conductor. Tin the exposed end of each conductor using solder and a soldering iron.
6. Clean the area.
7. Select a conductor foil jumper to match the width and thickness of the conductor to be replaced. Cut a length approximately as needed. The foil jumper should overlap the existing conductor a minimum of 2 times the conductor width.

   NOTE

   The new conductor may be trimmed from copper sheet.
8. Gently abrade the top and bottom surface of the replacement foil jumper with a buffer to remove the protective coating.

   NOTE

   A thin protective coating is often applied to the replacement foil jumper to prevent oxidation.
9. Clean the conductor foil jumper.
10. If needed, the ends of the replacement conductor foil jumper may be tinned with solder prior to lap soldering it in place.
11. If the conductor foil jumper is long or has bends, one end may be soldered prior to forming the new shape. Place the foil jumper in position. The foil jumper should overlap the existing conductor a minimum of 2 times the conductor width. The jumper may be held in place with Polyimide tape. (See Figure 2.)
12. Apply a small amount of liquid flux to the overlap joint.
13. Lap solder the foil jumper to the conductor on the printed wiring board surface using solder and a soldering iron. Make sure the foil jumper is properly aligned.

    NOTE

    If the configuration permits, the overlap solder joint connection should be a minimum of 3.00 mm from the related termination. This gap will minimize the possibility of simultaneous reflow during soldering operations.
14. Bend the foil jumper as needed to match the shape of the missing conductor. (See Figure 3.)

    NOTE

    Two wood sticks can be used to make sharp bends in the replacement foil jumper. Use one stick to hold the new jumper at the bend location and use the other wood stick to form the shape as needed.
15. Wide conductors that cannot be easily formed may be folded over to produce a sharp bend. (See Figure 4.)
16. Form the final shape of the jumper and hold in place with tape. Lap solder the foil jumper to the remaining conductor on the printed wiring board surface using solder and a soldering iron. Remove the tape used to hold the foil jumper. Clean the area. (See Figure 5.)
17. Mix the epoxy. If desired, add color agent to the mixed epoxy to match the printed wiring board color.

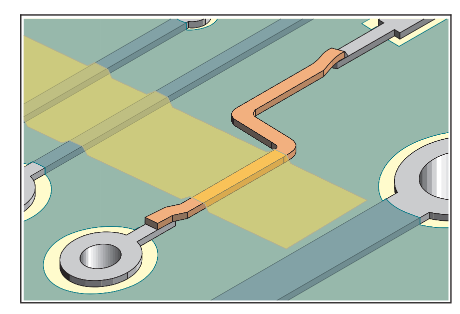


Figure 5 Form the final shape of the jumper and hold in place with tape.

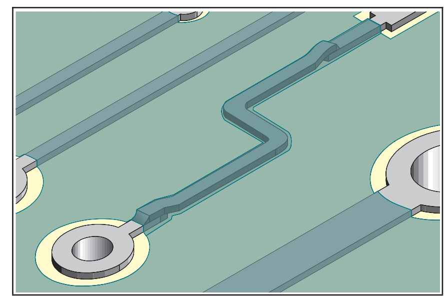


Figure 6 Coat the top and sides of the foil jumper with epoxy.

18. Coat the top and sides of the foil jumper with epoxy. The epoxy bonds the foil jumper to the printed wiring board surface and insulates it. A wooden stick sharpened at one end may be used to apply and spread the epoxy. (See Figure 6.)
19. Cure the epoxy per the manufacturers instructions.

    CAUTION

    Some components may be sensitive to high temperature.
20. Apply surface coating to match prior coating as required.

EVALUATION

1. Visual examination for alignment and overlap of foil jumper.
2. Visual examination of epoxy coating for texture and color match.
3. Electrical tests as applicable.

NOTES



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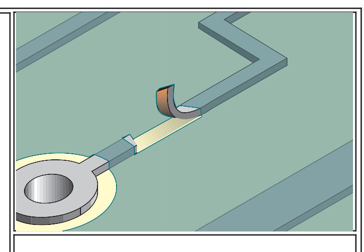
Repair and Modification of Printed Boards and Electronic Assemblies

Revision:

Date: **2/98**

Number: **4.2.2**

Conductor Repair, Foil Jumper, Film Adhesive Method



Product Class: R, F, C

Skill Level: Advanced

Level of Conformance: High

OUTLINE

This method is used to replace damaged or missing conductors on the printed wiring board surface.

CAUTION

It is essential that the board surface be extremely smooth and flat. If the base board is damaged see appropriate procedure.

REFERENCES

2.1 Handling Electronic Assemblies
2.2 Cleaning
2.5 Baking and Preheating
2.6 Epoxy Mixing and Handling

TOOLS & MATERIALS

Bonding Iron
Bonding System
Bonding Tips
Buffer
Conductor Foil Jumpers with Film Adhesive
Cleaner
Cleaner Wipes
Heat Lamp
Polyimide Tape
Knife
Liquid Flux
Microscope
Oven
Scraper
Solder
Soldering Iron
Tweezers

PROCEDURE

1. Clean the area.
2. Remove the damaged section of conductor using a knife. The damaged conductor should be trimmed back to a point where the conductor still has a good bond to the printed wiring board surface.
3. Use the knife and scrape off any epoxy residue, contamination or burned material from the board surface.
4. Scrape off any solder resist or coating from the connecting conductor. (See Figure 1.)
5. Clean the area.
6. Apply a small amount of liquid flux to the connection area on the board surface and tin with solder. Clean the area. The length of the overlap solder connection should be a minimum of 2 times the conductor width.

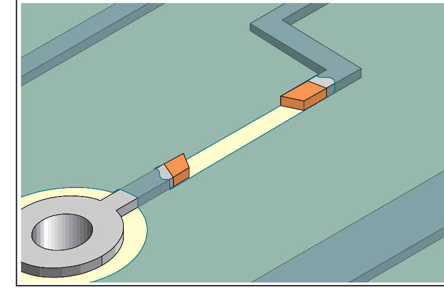


Figure 1 Remove solder mask from the connecting conductor.

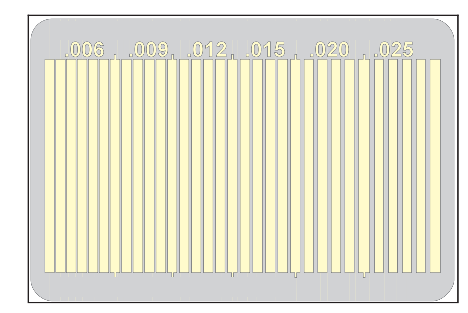


Figure 2 Replacement conductors with dry film adhesive backing.

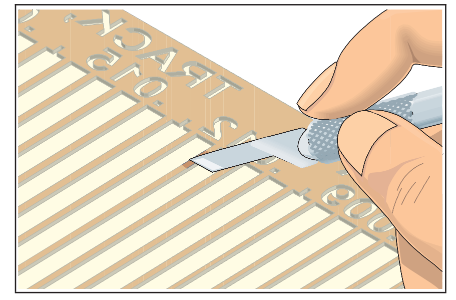


Figure 3 Scrape off epoxy bonding film.

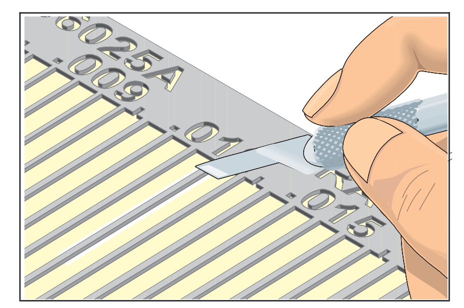


Figure 4 Cut out the new conductor. Cut from the plated side.

7. Select a replacement conductor with film adhesive backing that most closely matches the size of the conductor to be replaced. If a special size or shape is needed they can be custom fabricated. (See Figure 2.)

   NOTE
   New conductors are fabricated from copper foil. The foil is plated on the top side with solder and an epoxy bonding film is applied to the bottom side.

8. Before trimming out the new conductor carefully scrape off the adhesive epoxy film from the solder joint connection area on the back of the new conductor. (See Figure 3.)

   CAUTION
   Scrape off the epoxy backing only from the joint connection area. When handling the new conductor avoid touching the epoxy backing with your fingers or other materials that may contaminate the surface and reduce the bond strength.

9. Cut out and trim the new conductor. Cut out from the plated side. Cut the length to provide the maximum allowable conductor overlap for soldering. Minimum 2 times the conductor width. (See Figure 4.)

   NOTE
   If the configuration permits, the overlap solder joint connection should be a minimum of 3.00 mm from the related termination. This gap will minimize the possibility of simultaneous reflow during soldering operations.

10. Place a piece of tape over the top surface of the new conductor. Place the new conductor into position on the printed wiring board surface using tape to help in alignment. Leave the tape in place during the bonding cycle. (See Figure 5.)

11. Select a bonding tip with a shape to match the shape of the new conductor.

   NOTE
   The bonding tip should be as small as possible but should completely cover the entire width of the new conductor.

12. Position the printed wiring board so that it is flat and stable. Gently place the hot bonding tip onto the tape covering the new pad. Apply pressure as recommended in the manual of the repair system or repair kit. (See Figure 6.)

13. After the bonding cycle lift the bonding iron and remove the tape used for alignment. The new conductor is fully cured. Carefully clean the area and inspect the new conductor for proper alignment.

14. Apply a small amount of liquid flux to the lap solder joint connection area and solder the conductor from the new conductor to the conductor on the printed wiring board surface. Use minimal flux and solder to ensure a reliable connection. Tape may be placed over the top of the new conductor to prevent excess solder overflow. Clean the area.

15 Mix epoxy and coat the lap solder joint connections. Cure the epoxy per the manufacturer's instructions.

   CAUTION
   Some components may be sensitive to high temperature.

16. Apply surface coating to match prior coating as required.

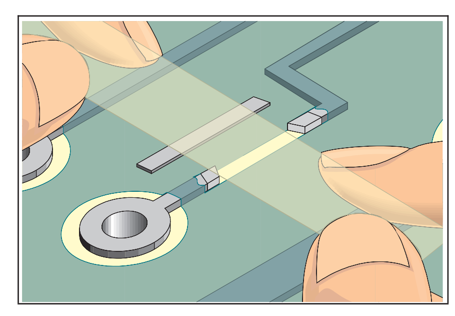


Figure 5 Place the new conductor in place using tape.



Figure 6 Repair system.

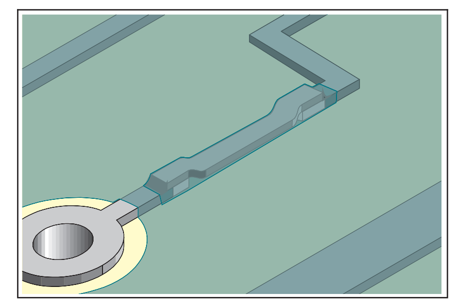


Figure 7 Completed repair.

EVALUATION

1. Visual examination
2. Measurement of new pad width and spacing.
3. Electrical continuity measurement.

Number: **4.2.2**	Subject: **Conductor Repair, Foil Jumper, Film Adhesive Method**
Revision: Date: 2/98	

NOTES



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Repair and Modification of Printed Boards and Electronic Assemblies

Revision:

Date: **2/98**

Number: **4.2.3**

Conductor Repair, Welding Method

Product Class: R, F, C
Skill Level: Advanced
Level of Conformance: High

OUTLINE

This procedure is used to repair short breaks or opens in conductors on printed wiring boards. A parallel gap welder is used to weld a jumper ribbon across the damaged conductor.

CAUTION

Welding current and voltages may affect component reliability on assembled printed wiring boards.

CAUTION

The repaired section must not reduce the conductor width, spacings or current carrying capacity below the allowable tolerances.

REFERENCES

2.1 Handling Electronic Assemblies
2.2 Cleaning
2.6 Epoxy Mixing and Handling

PREPARATION

Prior to using any welding equipment, certain precautions should be taken. The equipment should have electrodes cleaned, aligned and set for the proper board thickness.

Test samples that have similar conductor widths, spacing, thickness, surface finish, contour, etc. Observe and test the weld quality, alignment, discoloration, fusion and the appearance of the base material in the area of the weld. Readjust the weld equipment settings and repeat until acceptable results have been achieved.

The alignment of the welded ribbon to the conductor pattern should be within 0.050 mm. The weld bond strength should exceed the conductor/base material bond strength.

TOOLS & MATERIALS

Cleaner
Cleaner Wipes
Epoxy
Knife
Kovar Ribbon
Liquid Flux
Microscope
Parallel Gap Welder
Ribbon - Gold Plated Kovar
Solder
Soldering Iron
Tweezers

Number: **4.2.3**	Subject: **Conductor Repair, Welding Method**
Revision: Date: 2/98	

PROCEDURE

1. Clean the area.
2. Select a section of Kovar ribbon of the same width as the conductor pattern being repaired ± .050 mm.
3. Cut the ribbon approximately 3.0 mm longer than the section being repaired.
4. Clean the ribbon conductor and base material surrounding the repair area.
5. Place and center the ribbon over the section to be repaired leaving equal ribbon end lengths on each side and parallel to the conductor pattern.
6. Place the printed wiring board under the weld electrodes so that the electrodes are depressed to the area of the weld.
7. Hold the ribbon in place with tweezers until the weld is completed. Weld in place using settings based on the accepted test samples.
8. Clean the area.
9. Carefully inspect the joint for weld quality and alignment.
10. If required, apply a small amount of flux and tin the entire area with solder.
11. Clean the area.
12. Coat the repaired area with epoxy if needed.

EVALUATION

1. Visual examination, dimensional measurement of conductor width and spacing, and electrical continuity measurement.

NOTES



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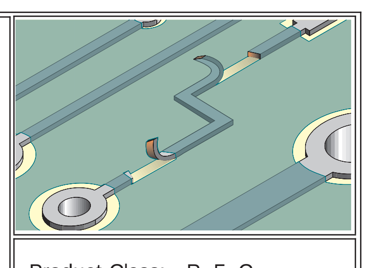
Repair and Modification of Printed Boards and Electronic Assemblies

Revision:

Date: **2/98**

Number: **4.2.4**

Conductor Repair, Surface Wire Method



Product Class: R, F, C

Skill Level: Intermediate

Level of Conformance: Medium

OUTLINE

This method is used on printed wiring boards to replace damaged or missing conductors on the printed wiring board surface. A length of standard insulated or non-insulated wire is used to repair the damaged conductor.

CAUTION

The conductor widths, spacing and current carrying capacity must not be reduced below allowable tolerances.

REFERENCES

2.1 Handling Electronic Assemblies
2.2 Cleaning
2.5 Baking and Preheating

TOOLS AND MATERIALS

Cleaner	Microscope
Cleaning Wipes	Oven
Epoxy	Scraper
Heat Lamp	Solder
Polyimide Tape	Soldering Iron with Tips
Knife	Wire
Light	Wire Guide Tool
Liquid Flux	

PROCEDURE

1. Clean the area.
2. Remove the damaged section of conductor using a knife. The damaged conductor should be trimmed back to a point where the conductor still has a good bond to the printed wiring board surface.

   NOTE
   Heat can be applied to the damaged conductor using a soldering iron to allow the conductor to be removed more easily.
3. Use a knife and scrape off any solder resist or coating from the ends of the remaining conductor. (See Figure 1.)
4. Remove all loose material. Clean the area.
5. Apply a small amount of liquid flux to the ends of the remaining conductor. Tin the exposed end of each conductor using solder and a soldering iron.
6. Clean the area.

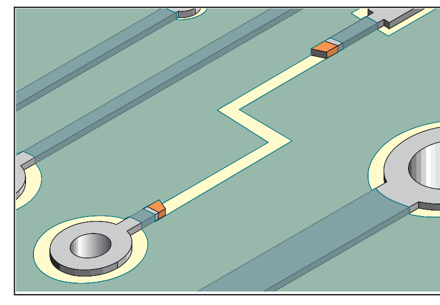


Figure 1 Scrap off any coating from the ends of the conductors.

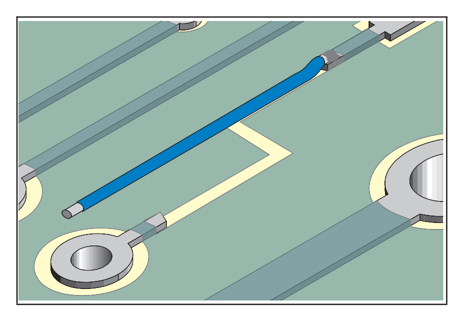


Figure 2 Lap solder the wire to one end of the conductor.

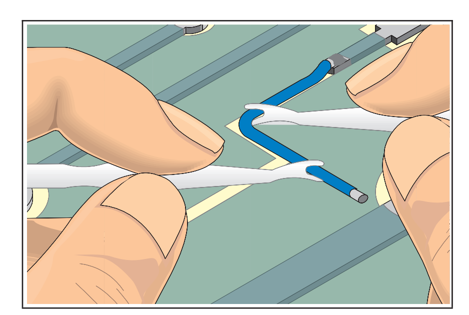


Figure 3 Form wire using wire guide tools.

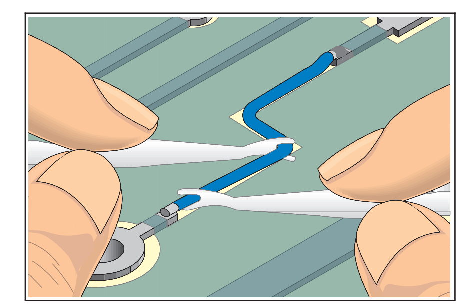


Figure 4 Form the final shape of the wire and solder in place.

7. Select a wire to match the width and thickness of the conductor to be replaced. Cut a length approximately as needed. See Table 1 for Solid Wire Equivalents.

Table 1 Solid Wire Equivalents

Conductor Width 2 oz. Copper	Equivalent Solid Wire Diameter
0.25 mm	#34, 0.15 mm
0.38 mm	#32, 0.20 mm
0.50 mm	#31, 0.23 mm
0.78 mm	#29, 0.28 mm
2.08 mm	#26, 0.46 mm
3.18 mm	#23, 0.58 mm
When using solid wire to repair a conductor, there should be no reduction in the cross sectional area.	

8. Strip the wire and tin the ends if needed. Non-insulated wire may be used for short repairs if conductors are not crossed.
9. Clean the wire.
10. If the wire is long or has bends, one end may be soldered prior to forming the new shape. Place the wire in position. The wire should overlap the existing conductor a minimum of 2 times the conductor width. The wire may be held in place with Polyimide tape during soldering.

    NOTE
    If the configuration permits, the overlap solder joint connection should be a minimum of 3.00 mm from the related termination. This gap will minimize the possibility of simultaneous reflow during soldering operations. Refer to 7.1 Soldering Basics.
11. Apply a small amount of liquid flux to the overlap joint.
12. Lap solder the wire to one end of the conductor on the printed wiring board surface. Make sure the wire is properly aligned. (See Figure 2.)
13. Bend the wire as needed to match the shape of the missing conductor. (See Figure 3.)

    NOTE
    Wire guide tools can be used to form the wire as needed.
14. Lap solder the other wire end to the remaining conductor on the printed wiring board surface using solder and a soldering iron. Make sure the wire is properly aligned. (See Figure 4.)
15. Remove any Polyimide tape and clean the area.

    NOTE
    It may be necessary to encapsulate the solder joint connection if electrical spacing is reduced or the connection is beneath a component.
16. If desired bond the wire to the printed wiring board surface with adhesive, epoxy or tape dots. (See Figure 5.)

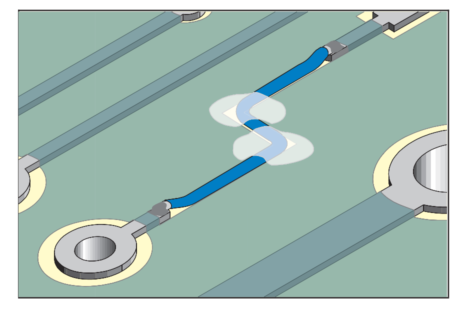


Figure 5 Bond the wire to the surface with adhesive or tape.

CAUTION
Some components may be sensitive to high temperature.

17. Cure the epoxy per the manufacturers instructions.
18. After the epoxy has cured clean the area.

EVALUATION

1. Visual examination for alignment and overlap of wire.
2. Electrical tests as applicable.

NOTES



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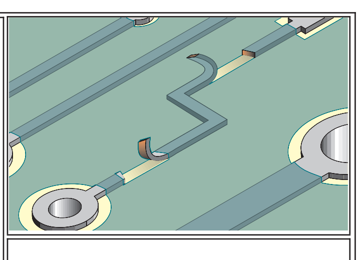
Repair and Modification of Printed Boards and Electronic Assemblies

Revision: **A**

Date: **11/99**

Number: **4.2.5**

Conductor Repair, Through Board Wire Method



Product Class: R

Skill Level: Advanced

Level of Conformance: Medium

OUTLINE

This method is used on printed wiring boards to replace damaged or missing conductors on the printed wiring board surface. A length of standard insulated or non-insulated wire is used to repair the damaged conductor.

CAUTION

The conductor widths, spacing and current carrying capacity must not be reduced below allowable tolerances.

CAUTION

This method is not acceptable when wire will be subsequently subjected to a mass soldering operation.

REFERENCES

2.1 Handling Electronic Assemblies

2.2 Cleaning

2.5 Baking and Preheating

TOOLS AND MATERIALS

Cleaner	Solder
Knife	Soldering Iron with Tips
Liquid Flux	Wipes
Dental Style Drill	Solid Wire
Microscope	

PROCEDURE

1. Clean the area.
2. Remove the damaged section of conductor using the knife. The damaged conductor should be trimmed back to a point where the conductor still has a good bond to the printed wiring board surface.

   NOTE

   Heat can be applied to the damaged conductor using a soldering iron to allow the conductor to be removed more easily.
3. Use a knife and scrape off any solder resist or coating from the ends of the remaining conductor. (See Figure 1.)
4. Remove all loose material. Clean the area.
5. Apply a small amount of liquid flux to the ends of the remaining conductor. Tin the exposed end of each conductor using solder and a soldering iron.

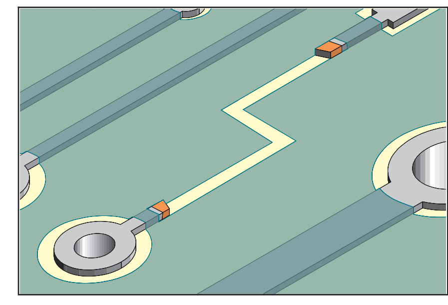


Figure 1 Scrape off any coating from ends of remaining conductors.

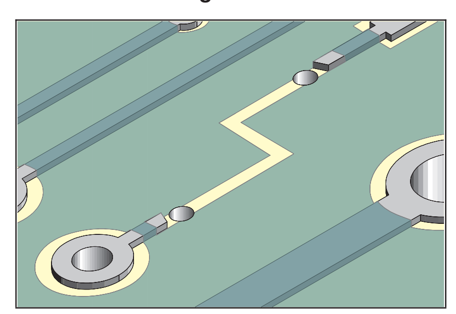


Figure 2 Drill through board adjacent to conductor.

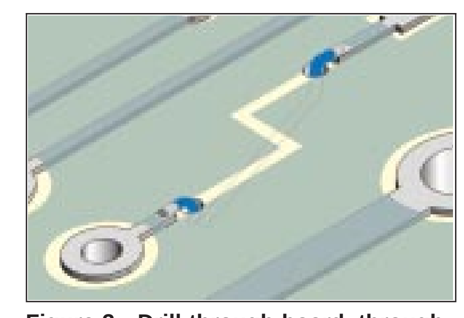


Figure 3 Drill through board, through conductors.

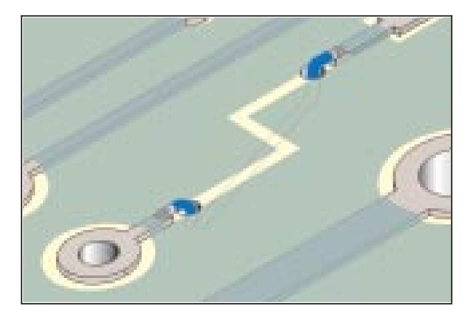


Figure 4 Lap solder wire to conductor.

6. Clean the area.
7. Select a wire to match the width and thickness of the conductor to be replaced. Cut a length approximately as needed. See Table 1 for Solid Wire Equivalents.

Table 1 Solid Wire Equivalents

Conductor Width 2 oz. Copper	Equivalent Solid Wire Diameter
0.25 mm	#34, 0.15 mm
0.38 mm	#32, 0.20 mm
0.50 mm	#31, 0.23 mm
0.78 mm	#29, 0.28 mm
2.08 mm	#26, 0.46 mm
3.18 mm	#23, 0.58 mm
When using solid wire to repair a conductor, there should be no reduction in the cross sectional area.	

8. Strip the wire and tin the ends if needed. Non-insulated wire may be used for short repairs if conductors are not crossed.
9. Clean the wire.

   CAUTION

   Review conductor diagrams to be sure no surface or internal conductors will be damaged or shorted.
10. Drill through the board, either adjacent to both ends of the remaining conductors or through the conductors. Drill the hole slightly larger than the wire diameter to be used. (See Figure 2.)
11. Position the wire on the opposite side from the repair and insert the stripped ends into the drilled holes.
12. Bend the stripped wire over the prepared conductors in line with the conductors. The wire should overlap the existing conductor a minimum of 2 times the conductor width. (See Figure 3.)

    NOTE

    If the configuration permits, the overlap solder joint connection should be a minimum of 3.00 mm from the related termination. This gap will minimize the possibility of simultaneous reflow during soldering operations.
13. Apply a small amount of liquid flux to the overlap joint.
14 Lap solder the wire to the conductors on the printed wiring board surface. Make sure the wire is properly aligned. (See Figure 4.)
15. Form the wire on the opposite side to match the shape of the missing conductor.
16. Clean the area.

    NOTE

    It may be necessary to encapsulate the solder joint connection if electrical spacing is reduced.

17. If desired bond the wire to the printed wiring board surface with adhesive, epoxy or Tape Dots.

    CAUTION

    Some components may be sensitive to high temperature.

18. Cure the epoxy per Procedure 2.7 Epoxy Mixing and Handling.
19. After the epoxy has cured clean the area.

EVALUATION

1. Visual examination for alignment and overlap of wire.
2. Electrical tests as applicable.

NOTES



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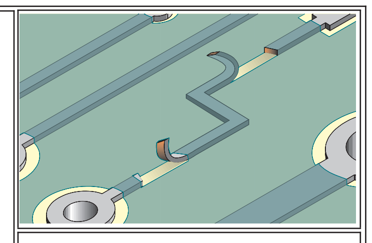
Repair and Modification of Printed Boards and Electronic Assemblies

Revision:

Date: **2/98**

Number: **4.2.6**

Conductor Repair/ Modification, Conductive Ink Method



Product Class: R, F, C

Skill Level: Expert

Level of Conformance: Medium

OUTLINE

This modification/repair conductive pattern is fabricated via a solder/copper composite of screen printable polymer thick film (PTF). The interconnects are established at conductor lands and through hole locations of the original conductor. Electrical continuity is optimized between two or more points of interconnection by solder fusion of the new conductor pattern to the original etched PCB pattern.

NOTE

This modification/repair method is UL recognized, Type 1 94-V-0. It is compatible with both digital and analog printed wiring board applications and it has resistance of less than 3.0 milliohms/sq. It consists of greater than 90% copper and solder. The resin system employed is thermal setting and adhesion of approximately 1.5 kg on a 6 mm x 0.6 mm wide strip. It is typically applied to either or both sides of printed wiring boards on thru-hole or surface mount PCB's prior to assembly, without any final solder resist coating. (Line resist coating can be applied and it is considered optional.)

CAUTION

This modification/repair method can be employed on a single-sided, double-sided or a multilayer printed wiring board. Its primary application is for signal carrying conductors. New or additional power distribution should be designed into the new conductor pattern on the basis of 0.25 mm of line width 2.6 amps of current required, up to a maximum of 3.4 amps. When applying this method to the wave solder side or a thru-hole printed wiring board, it should be covered with a solder (line) resist.

REFERENCES

2.1 Handling Electronic Assemblies
2.2 Cleaning
2.5 Baking and Preheating

TOOLS AND MATERIALS

Screen printer/screens with matalizer and IR belt ovens
Modification/repair master artwork
Conductive Ink, directly solderable
SMT compatible solder paste
IR solder reflow (fuse) belt oven
Flux cleaner, deionized water
Electronic multi-point tester

PROCEDURE

1. Convert conductor design revision via CAD to additive layer conductor pattern including vias to be exposed and etch deletes to be performed.

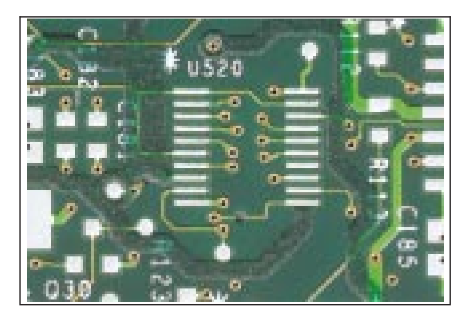


Figure 1 Isolation layer.

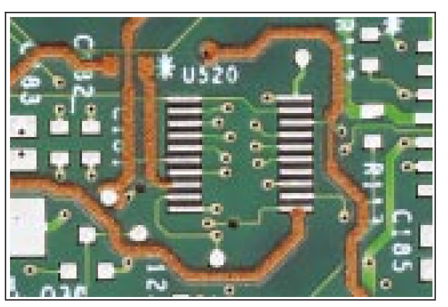


Figure 2 Copper ink is applied.

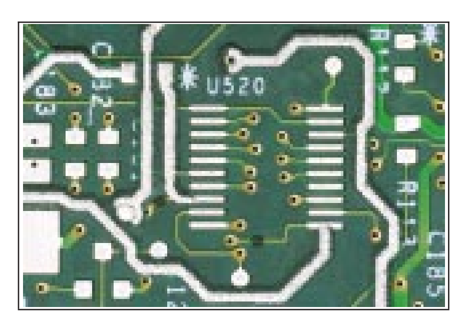


Figure 3 Solder ink fused to copper ink.

2. Expose CAD generated additive conductor patterns of new conductor revision in isolation layer, copper and solder screens.

3 Print and cure isolation layer of protective epoxy.

4 Print, metalize and cure the new conductive ink pattern which establishes the modified/repaired conductor.

5. Print the SMT compatible solder paste on to the cured conductive ink pattern, totally encompassing the underlying material.

6 Fuse the printed solder paste to form the electrical optimization of the new conductor and the interconnection to the original etched conductor. See reflow soldering (IPC-J-STD-001).

CAUTION

Care should be taken not to add any solder to any unmodified or un-repaired areas on the printed wiring board. All solder flux residue should be removed to meet IPC-TM-650, Test Methods 2.3.25 and 2.3.26, ionic contamination requirements.

EVALUATION

Visually examine and conduct dimensional measurement of conductor width and spacing. Ring-out for electrical continuity to detect for ‘shorts’ or ‘opens.’ This testing can be affected manually via continuity meter, automated electronic point-to-point tester or via a universal bed of nails electronic tester.

NOTE

Additive Conductor Modification Operations has become an industry standard for production quantities of PCB modification/repair revisions.

NOTE

Because of the expert level of workmanship required, qualified vendors of the service should be considered or the acquisition of dedicated in-house systems and personnel to perform this work.

NOTES



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Repair and Modification of Printed Boards and Electronic Assemblies

Revision:

Number: **4.2.7**

Date: **2/98**

Conductor Repair, Inner Layer Method

Product Class: R, F
Skill Level: Expert
Level of Conformance: High

OUTLINE

This method is used to replace damaged or missing conductors on internal layers of multilayer printed wiring boards.

CAUTION

The conductor widths, spacing and current carrying capacity must not be reduced below allowable tolerances.

CAUTION

The overlap joint used in this method may cause problems with high frequency circuitry.

CAUTION

This procedure is complicated and should be attempted only by properly skilled repair personnel using the best tools and equipment.

REFERENCES

2.1 Handling Electronic Assemblies
2.2 Cleaning
2.5 Baking and Preheating
2.6 Epoxy Mixing and Handling

TOOLS AND MATERIALS

Ball Mills
Buffer
Conductor Foil Jumpers
Cleaner
Cleaning Wipes
Color Agent
Epoxy
Hand Held Drill
Heat Lamp
Polyimide Tape
Knife
Liquid Flux
Microscope
Oven
Scraper
Solder
Soldering Iron

PROCEDURE

1. Locate and determine the coordinates where the repair is to be made. Use films or master drawings of the board as needed.

   NOTE
   Obtain as much information as possible on the conductive and non-conductive layers prior to starting the procedure.

2. Remove components from the immediate area if necessary and clean the area.

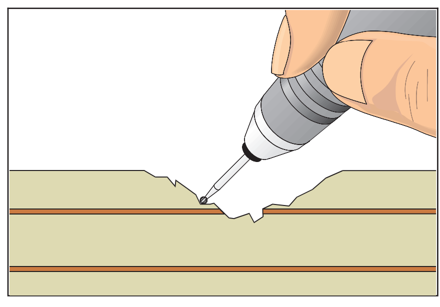


Figure 1 Milling into multilayer board to expose the damaged conductors.



Figure 2 A high quality, hand held drill.

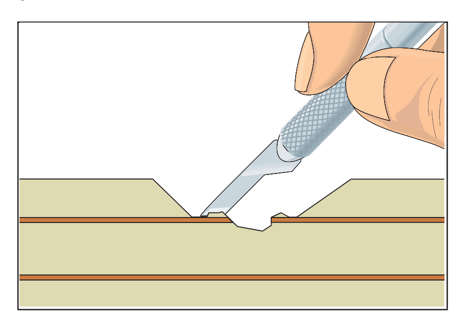


Figure 3 Remove the remaining board material with a knife.

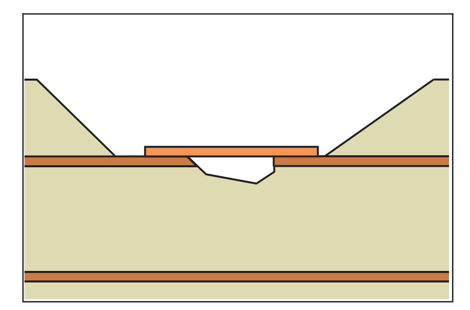


Figure 4 Conductor foil jumper in place ready to be soldered.

3. Use the microscope and hand held drill and cut through the base material, one layer at a time, until the desired inner layer has been reached. (See Figure 1 and 2.)

   CAUTION

   Great care should be taken to prevent further damage to internal conductors.

4. Each internal conductor should have a flat section exposed to allow the new conductor to be soldered in place. (See Figure 3.)

   NOTE

   To reduce damage to the internal conductor, complete the final exposure of the internal conductor using a knife. (See Figure 3.)

5. Remove all loose material. Clean the area.
6. Apply a small amount of liquid flux to the ends of the internal conductor. Tin the exposed end of each conductor using solder and a soldering iron.
7. Clean the area.
8. Select a replacement conductor foil jumper that most closely matches the size of the conductor to be replaced. Cut length approximately as needed.
9. Gently abrade the top and bottom of the conductor foil jumper with a buffer to remove any protective coating and clean.

   NOTE

   If needed, the ends of the conductor foil jumper may be tinned with solder prior to lap soldering in place.

10. Place the conductor foil jumper in position. The conductor foil jumper should overlap the existing conductor a minimum of 2 times the conductor width. (See Figure 4.)

    NOTE

    If spacing is critical or the printed wiring board uses high frequency conductors, bevel the joint. (See Figure 5.)

    CAUTION

    This bevel joint method may cause problems with printed wiring boards exposed to extreme temperature fluctuations.

11. Apply a small amount of liquid flux to the overlap joint.
12. Lap solder the conductor foil jumper to the exposed internal conductor using solder and a soldering iron. Make sure the new conductor is properly aligned.
13. Clean the area.

    NOTE

    The printed wiring board may be preheated prior to filling the area with epoxy. A preheated printed wiring board will allow the epoxy to easily flow and level out. Epoxy applied to an unheated printed wiring board may settle below the printed wiring board surface as the epoxy cures.

14. Mix epoxy. If desired, add color agent to the mixed epoxy to match the printed wiring board color.

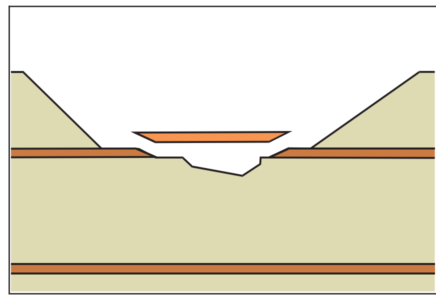


Figure 5 Bevel end joint.

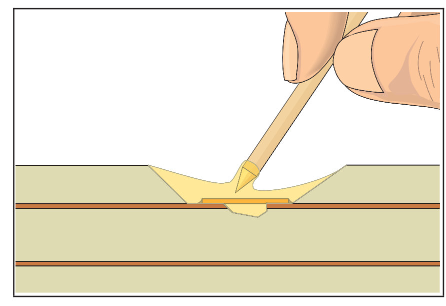


Figure 6 Coat the top and sides of the new conductor with epoxy.

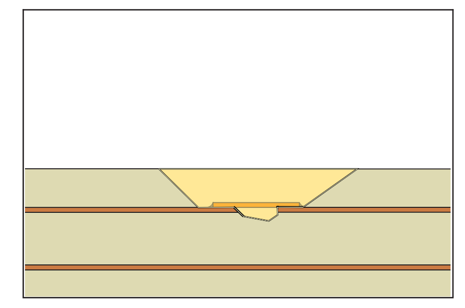


Figure 7 Completed repair.

15. Coat the top and sides of the replaced conductor with epoxy. The epoxy bonds the new conductor to the base board material and insulates the conductor. Continue adding epoxy up to the top surface of the printed wiring board or to the height of the next internal conductor. (See Figure 6.)

    NOTE
    A slight overfill of epoxy may be desired to allow for shrinkage when the epoxy cures.

16. Cure the epoxy per the manufacturer's instructions.

    CAUTION
    Some components may be sensitive to high temperature.

17. Add additional conductor foil jumpers if needed and coat with additional epoxy.
18. Continue completing all layers until the top surface of the printed wiring board is reached. (See Figure 7.)
19. Clean the board as required.
20. Apply surface coating to match prior coating as required.

EVALUATION

1. Visual examination for alignment and overlap of new conductor.
2. Visual examination of epoxy coating for texture and color match.
3. Electrical tests as applicable.

Number: 4.2.7	Subject: **Conductor Repair, Inner Layer Method**
Revision: Date: 2/98	

NOTES



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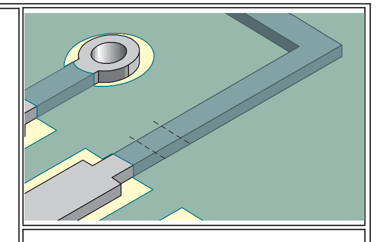
Repair and Modification of Printed Boards and Electronic Assemblies

Revision: A

Date: 10/03

Number: **4.3.1**

Conductor Cut, Surface Conductors



Product Class: R, F

Skill Level: Advanced

Level of Conformance: High

OUTLINE

This method is used to sever a conductor or short. A small section of the conductor is removed forming a break. The width of the break should be at least as wide as the minimum conductor spacing. A knife or high speed, hand held drill is used. This method is recommended for surface conductor cuts only. After cutting, the area is sealed with epoxy.

NOTE

This method is recommended for surface conductor cuts only.

REFERENCES

2.1 Handling Electronic Assemblies
2.2 Cleaning
2.6 Epoxy Mixing and Handling

TOOLS AND MATERIALS

Ball Mills, Carbide	Epoxy Dispensing System
Cleaner	Hand Held Drill
Cleaner Wipes	Heat Lamp
Color Agent	Knife
Continuity Meter	Microscope
Epoxy	Oven

PROCEDURE

1. Identify the conductor or short to be cut. Determine from the artwork or drawings where the best location is to make the break. The width of the break should at least match the minimum required electrical spacing.
2. Clean the area.

3A. Carefully make two small cuts with the knife and remove the short section of conductor. (See Figure 1.) An alternate method is to use a handheld drill as discussed in Step 4 and shown in Figure 3.

NOTE

If desired, remove a second section of the conductor at the opposite end to eliminate the potential of the conductor acting as an antenna.



3B. Select the appropriate size ball mill and insert it into the dental style drill. Set the speed to high. (See Figure 2.) The ball mill should be approximately the same width as the conductor to be cut. (See Table 1 for standard ball mill sizes.)

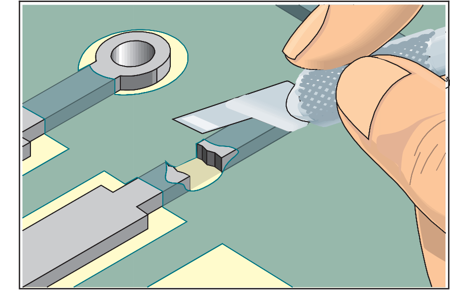


Figure 1 Make two small cuts with a knife and remove section of conductor.

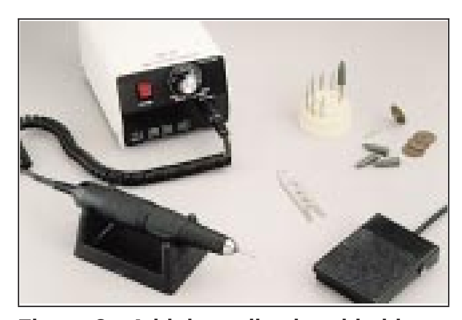


Figure 2 A high quality, hand held drill.

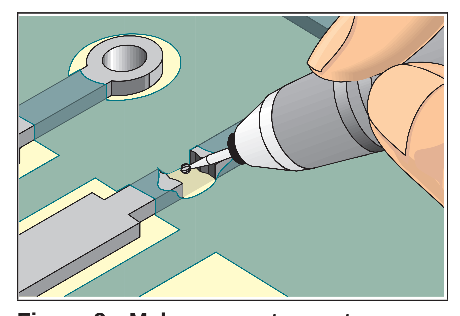


Figure 3 Make one or two cuts as needed to cut conductor.

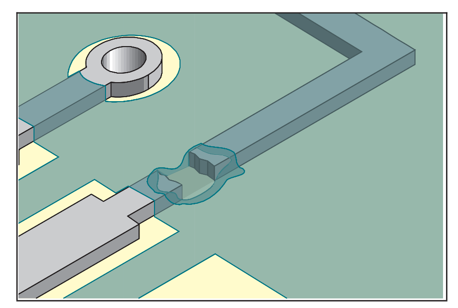


Figure 4 Completed repair.

Table 1 Standard Ball Mill Sizes

0.50 mm Diameter
0.70 mm Diameter
0.80 mm Diameter
1.00 mm Diameter
1.20 mm Diameter
1.40 mm Diameter
1.60 mm Diameter
1.80 mm Diameter
2.10 mm Diameter

CAUTION
Abrasion operations can generate electrostatic charges.

NOTE
Ball mills should be dental grade carbide steel for precision cutting and long life.

4. Carefully make 1 or 2 cuts as needed. (See Figure 3.)

   CAUTION
   Exercise care to avoid damage to adjoining conductors.

   NOTE
   If desired, remove a second section of the conductor at the opposite end to eliminate the potential of the conductor acting as an antenna.

5. Check continuity to be sure that the conductor has been cut.
6. Clean the area.
7. Mix epoxy. If desired, add color agent to the mixed epoxy to match the printed wiring board color.
8. Coat the area with epoxy if needed. An epoxy dispenser may be used to accurately control the application of epoxy. Remove any excess epoxy.
9. Cure the epoxy per the manufacturer's instructions.

   CAUTION
   Some components may be sensitive to high temperatures.

EVALUATION

1. Visual examination of cuts for spacing, and unintended damage to surrounding conductors.
2. Electrical tests as applicable.

NOTES



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Repair and Modification of Printed Boards and Electronic Assemblies

Revision:

Date: **2/98**

Number: **4.3.2**

Conductor Cut, Inner layer Conductors

Product Class: R, F
Skill Level: Advanced
Level of Conformance: High

OUTLINE

This method is used to sever a conductor or short. A small section of the conductor is removed forming a break. The width of the break should be at least as wide as the minimum conductor spacing. A precision drill system is used with a carbide end mill. This method is recommended for surface or inner layer conductor cuts. After milling, the area is sealed with epoxy.

NOTE

This method is recommended for surface or inner layer conductor cuts.

CAUTION

Extreme care must be taken to prevent damage to adjacent or underlying inner layer conductors. A microscope must be used during milling when extreme accuracy is required.

REFERENCES

2.1 Handling Electronic Assemblies
2.2 Cleaning
2.6 Epoxy Mixing and Handling

TOOLS AND MATERIALS

Cleaner	Epoxy Dispensing System
Cleaner Wipes	Heat Lamp
Color Agent	Microscope
Continuity Meter	Precision Drill Press
End Mills, Carbide	Oven
Epoxy	

PROCEDURE

1. Identify the conductor or short to be cut. Determine from the artwork or drawings where the best location is to make the break. The width of the break should at least match the minimum required electrical spacing.
2. Clean the area.
3. If the cut is on an inner layer conductor, mark the coordinates on the printed wiring board surface or set up a fixture to precisely locate the board in the precision drill press. (See Figure 1.)
4. Select the appropriate size end mill or ball mill and insert it into the chuck of the precision drill press. The milling cutter should be slightly larger in diameter than the conductor to be cut. Set speed to high.



Figure 1 Precision drill press with base plate.

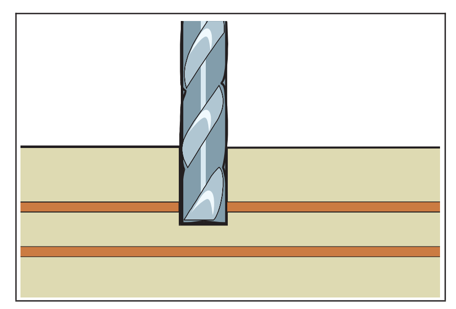


Figure 2 Mill into PC board at proper coordinates.

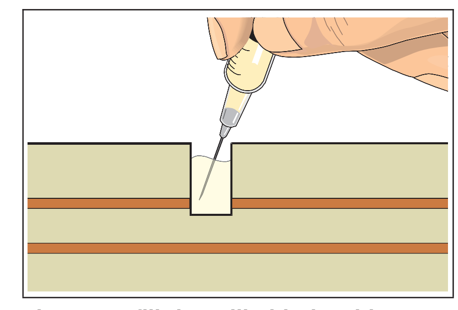


Figure 3 fill the milled hole with epoxy up to and flush with the surface.

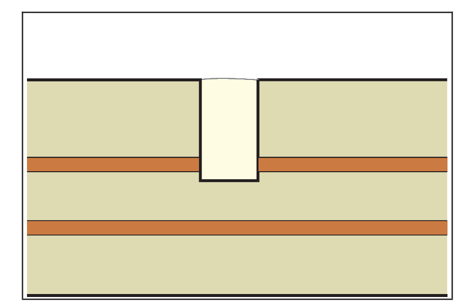


Figure 4 Completed repair.

Number: **4.3.2**	Subject: **Conductor Cut, Inner Layer Conductors**
Revision: Date: 2/98	

CAUTION
Abrasion operations can generate electrostatic charges.

NOTE
End mills are normally single end, two or four flute high grade solid carbide.

5. Mill down into the board at the proper coordinates to cut the inner layer conductors or to break the inner layer short. Do not mill deeper than needed. A microscope should be used for accuracy. (See Figure 2.)
6. Blow away material with air and clean the area.
7. Check continuity to be sure that the conductor has been cut.
8. Mix epoxy. If desired, add color agent to the mixed epoxy to match the printed wiring board color.
9. Fill the milled hole with epoxy up to and flush with the surface. An epoxy dispenser may be used to accurately control the application of epoxy. Remove any excess epoxy. (See Figure 3.)

   CAUTION
   Examine milled hole to be sure all material is removed from the hole prior to filling the hole with epoxy.

   NOTE
   A slight overfill of epoxy may be desired to allow for shrinkage when epoxy cures.
10. Cure the epoxy per the manufacturer's instructions.

    CAUTION
    Some components may be sensitive to high temperatures.

EVALUATION

1. Visual examination of cuts for spacing, and unintended damage to surrounding conductors.
2. Electrical tests as applicable.

NOTES



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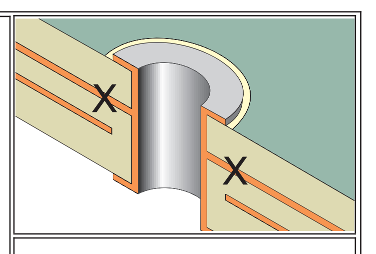
Repair and Modification of Printed Boards and Electronic Assemblies

Revision:

Date: 2/98

Number: 4.3.3

Deleting Inner Layer Connection At A Plated Hole, Drill Through Method



Product Class: R, F
Skill Level: Advanced
Level of Conformance: High

OUTLINE

This method is used on multilayer printed wiring boards or assemblies to disconnect an internal connection at a plated hole. A precision drill press is used with a carbide drill, end mill or ball mill to drill out the hole. The hole may then be filled with epoxy and redrilled to the diameter needed.

CAUTION

Extreme care must be taken to prevent damage to adjacent conductors. A microscope must be used during milling when extreme accuracy is required.

REFERENCES

2.1 Handling Electronic Assemblies
2.2 Cleaning
2.5 Baking and Preheating
2.6 Epoxy Mixing and Handling

TOOLS AND MATERIALS

Cleaner
Cleaner Wipes
Color Agent
Continuity Meter
End Mills, Carbide
Epoxy
Epoxy Dispensing System
Heat Lamp
Polyimide Tape
Oven
Microscope
Pin Clamps
Precision Drill Press

PROCEDURE

1. Identify the hole that requires rework and clean the area.
2. Mark the coordinates on the board surface and pin the printed wiring board in place on the base plate of the precision drill press. (See Figure 1.)
3. Select the appropriate size end mill, drill or ball mill and insert it into the chuck of the precision drill press. The cutting tool should be approximately 0.50 mm greater than the plated through hole inside diameter. Set speed to high.

   CAUTION

   Abrasion operations can generate electrostatic charges.

   NOTE

   End mills are normally single end, two or four flute high grade solid carbide.
4. Completely mill through the hole to isolate the internal connection(s). A microscope should be used for accuracy. (See Figure 2.)
5. Blow away material with air and clean the area.
6. Check continuity to be sure that the internal connection has been deleted. Also



Figure 1 Precision drill press with base plate.

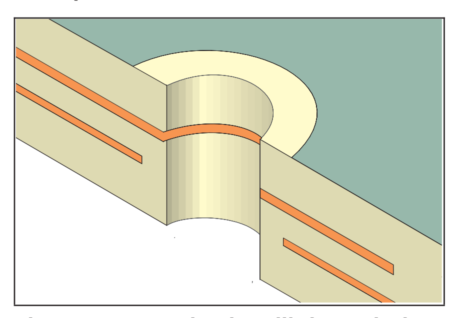


Figure 2 Completely mill through the hole.

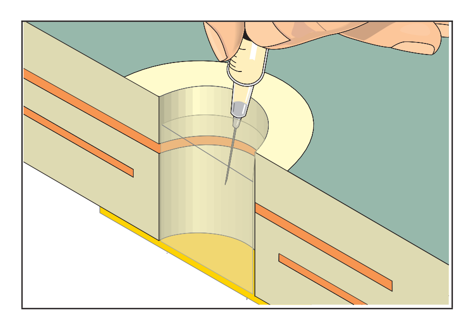


Figure 3 Fill the hole with epoxy up to and flush with the surface.

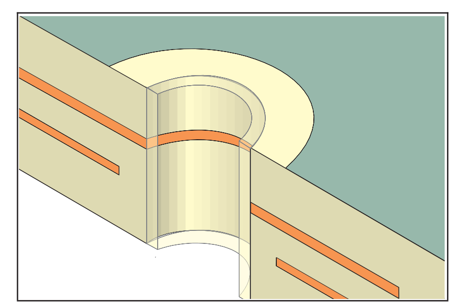


Figure 4 Repair complete.

check the continuity and inspect the neighboring conductors to make sure that none of them have been severed or damaged.

If desired complete the following steps

7. Mask the opposite side with Polyimide tape or flexible mask to prevent the epoxy from flowing out the opposite side.
8. Mix the epoxy.
9. Fill the hole with epoxy up to and flush with the surface. Remove excess epoxy. (See Figure 3.)

   NOTE
   A slight overfill of epoxy may be desired to allow for shrinkage when epoxy cures.
10. Cure the epoxy per the manufacturer's instructions.

    CAUTION
    Some components may be sensitive to high temperature.
11. Clean the area.
12. Select an end mill or drill as needed. Insert the cutting tool into the precision drill press. Mill directly through the center of the cured epoxy. The surface pad remaining may be used as a target location for accuracy. A microscope should be used during milling for accuracy. (See Figure 4.)

    CAUTION
    Be careful not to re-expose the internal layers of the hole when drilling out the epoxy.
13. Clean the area. Inspect the new hole using a microscope.

EVALUATION

1. Visual and electrical examination as required.

NOTES



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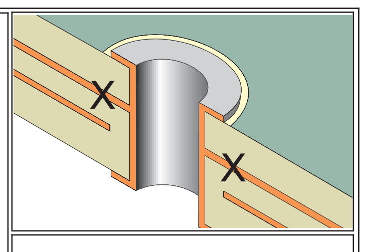
Repair and Modification of Printed Boards and Electronic Assemblies

Revision:

Date: **2/98**

Number: **4.3.4**

Deleting Inner Layer Connection At A Plated Hole, Spoke Cut Method



Product Class: R, F
Skill Level: Advanced
Level of Conformance: High

OUTLINE

This method is used on multilayer printed wiring boards or assemblies to disconnect an internal connection at a plated hole. A precision drill press is used with a carbide end mill to make precise cuts at the spokes or internal conductors extending from the hole.

CAUTION

Extreme care must be taken to prevent damage to adjacent conductors. A microscope must be used during milling when extreme accuracy is required.

REFERENCES

2.1 Handling Electronic Assemblies
2.2 Cleaning
2.5 Baking and Preheating
2.6 Epoxy Mixing and Handling

TOOLS AND MATERIALS

Cleaner
Cleaner Wipes
Color Agent
Continuity Meter
End Mills, Carbide
Epoxy
Epoxy Dispensing System
Heat Lamp
Polyimide Tape
Oven
Microscope
Pin Clamps
Precision Drill Press

PROCEDURE

1. Identify the hole that requires rework and clean the area.
2. Mark the coordinates on the board surface and place the printed wiring board on the base plate of the precision drill press. (See Figure 1.)
3. Select the appropriate size end mill or drill and insert it into the chuck of the precision drill press. The cutting tool should be approximately 0.010 - 0.025 mm greater than the width of the spoke or conductor to be cut. (See Table 1 for Standard End Mill Sizes.) Set speed to high.

   CAUTION
   Abrasion operations can generate electrostatic charges.

   NOTE
   End mills are normally single end, two or four flute high grade solid carbide.



Figure 1 Precision drill press with base plate.

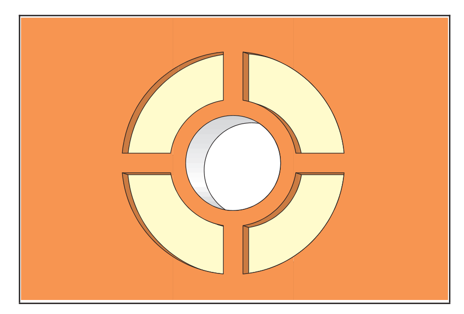


Figure 2 Plated-through hole with inner layer spoke connections.

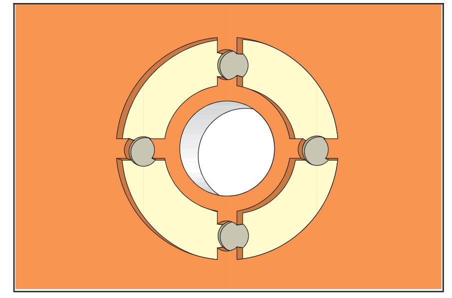


Figure 3 Mill adjacent to the plated hole to sever spoke connections.

Table 1 Standard End Mill Sizes

0.381 mm Diameter
0.635 mm Diameter
0.812 mm Diameter
1.016 mm Diameter
1.143 mm Diameter
1.397 mm Diameter
1.575 mm Diameter
2.362 mm Diameter
3.175 mm Diameter

4. Mill into the printed wiring board surface adjacent to the plated hole. The milled holes should be aligned directly above the internal spoke connections. Mill down just deep enough to sever the internal spokes connecting the plated hole to the internal plane. A microscope must be used for accuracy. Up to 4 milled holes may be required. Do not drill deeper than needed. (See Figure 3.)
5. Blow away material with air and clean the area.
6. Check continuity to be sure that the internal connection has been deleted. Also check the continuity and inspect the neighboring conductors to make sure that none of them have been severed or damaged.
7. Mix the epoxy.
8. Fill the holes with epoxy up to and flush with the surface. Remove excess epoxy.

   NOTE
   A slight overfill of epoxy may be desired to allow for shrinkage when epoxy cures.
9. Cure the epoxy per the manufacturer's instructions.

   CAUTION
   Some components may be sensitive to high temperature.
10. Clean the area.

EVALUATION

1. Visual and electrical examination as required.

NOTES



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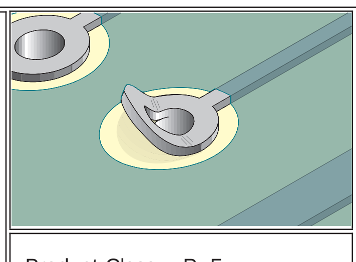
Repair and Modification of Printed Boards and Electronic Assemblies

Revision:

Date: **2/98**

Number: **4.4.1**

Lifted Land Repair, Epoxy Method



Product Class: R, F
Skill Level: Advanced
Level of Conformance: Medium

OUTLINE

This method is used to rebond a lifted land. Liquid epoxy is inserted under and around the land to bond it back down to the printed wiring board surface.

REFERENCES

2.1 Handling Electronic Assemblies
2.2 Cleaning
2.5 Baking and Preheating
2.6 Epoxy Mixing and Handling

TOOLS AND MATERIALS

Cleaner	Knife
Epoxy	Oven
Heat Lamp	Wipes
Polyimide Tape	

PROCEDURE

1. Clean the area.
2. Remove any obstructions that prevent the lifted land from making contact with the base board surface.

   CAUTION
   Be careful while cleaning and removing all obstructions, not to stretch or damage the lifted land.
3. Mix the epoxy.
4. Carefully apply a small amount of epoxy under the entire length of the lifted land. The tip of a knife or scraper may be used to apply the epoxy. (See Figure 1.)
5. Place a piece of Polyimide tape over the lifted land and press the land down into the epoxy and into contact with the base board material. (See Figure 2.)
6. Apply additional epoxy to the surface of the lifted land and to all sides as needed.
7. Cure the epoxy per the manufacturer's instructions.

   CAUTION
   Some components may be sensitive to high temperatures.

   NOTE
   Double sided and multilayer printed wiring boards, may require an eyelet to restore the through connection. Refer to section 5.0 Plated Hole Procedures.
8. Carefully remove any excess epoxy inside the plated hole using a ball mill or drill bit. Turn the ball mill or drill bit by hand to prevent damage to the wall of the plated through hole.

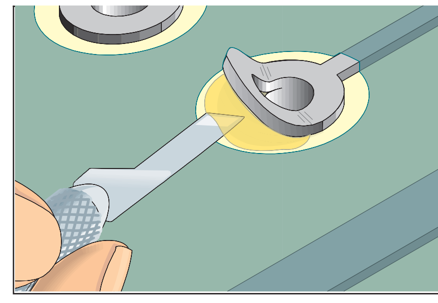


Figure 1 Apply epoxy under the entire length of the lifted land.

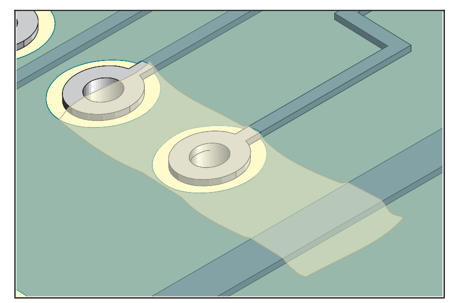


Figure 2 Place tape over the lifted land.

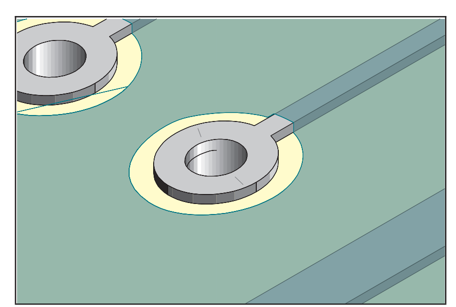


Figure 3 Completed repair.

9. Install the proper component and solder in place.

   NOTE
   This method is used to repair a lifted lands, but the repaired land may not have an intermetallic connection to the remaining plated hole. The solder joint of the replaced component will restore the integrity of the electrical connection or an eyelet or buss wire may be used. See Plated Hole Repair Procedures.

10. Replace surface coating to match prior coating as required.

EVALUATION

1. Visual examination and tape test per IPC-TM-650, Test Method 2.4.1.
2. Electrical tests as applicable.

NOTES



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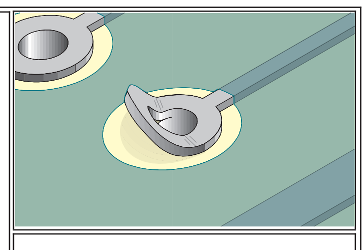
Repair and Modification of Printed Boards and Electronic Assemblies

Revision:

Date: **2/98**

Number: **4.4.2**

Lifted Land Repair, Film Adhesive Method



Product Class: R, F

Skill Level: Advanced

Level of Conformance: Medium

OUTLINE

This method is used to repair damaged and lifted lands. The lifted lands are repaired with dry film epoxy. They are re-bonded to the printed wiring board surface using a bonding press or bonding iron.

CAUTION

It is essential that the board surface be extremely smooth and flat. If the base board is damaged see appropriate procedure.

REFERENCES

2.1 Handling Electronic Assemblies

2.2 Cleaning

TOOLS & MATERIALS

Ball Mills	Polyimide Tape
Bonding Iron	Knife
Bonding System	Microscope
Bonding Tips	Scraper
Cleaner	Tweezers
Dry Film Adhesive	Wipes

PROCEDURE

1. Clean the area.
2. Remove any obstructions that prevent the lifted land from making contact with the base board material.
3. Use the knife and scrape off any epoxy residue, contamination or burned material from the board surface.
4. Clean the area.
5. Cut out a piece of bonding film that matches the area of the lifted land. Be careful not to contaminate the dry film epoxy with materials that could reduce the bond strength.

   NOTE

   Dry film adhesive thickness should be selected to meet the requirements of the printed wiring board.
6. Place the dry film under the lifted land. (See Figure 1).
7. Place a piece of Polyimide tape over the lifted land and press the land down into contact with the adhesive film. (See Figure 2).

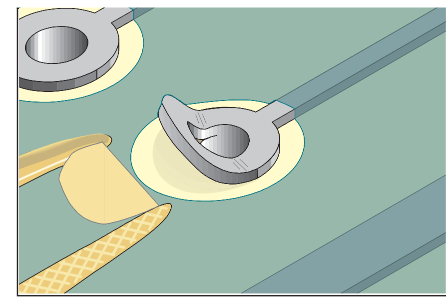


Figure 1 Cut out dry film material to match the area of the lifted land.

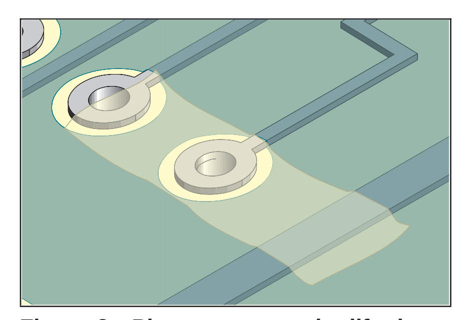


Figure 2 Place tape over the lifted land.



Figure 3 Bond the land down using a commercially available system.

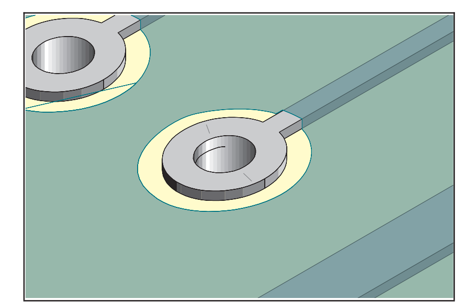


Figure 4 Completed repair.

8. Select a bonding tip with a shape to match the shape of the lifted land.

   NOTE
   The bonding tip should be as small as possible but should completely cover the entire surface of the new land.

9. Position the printed wiring board so that it is flat and stable. Gently place the hot bonding tip onto the tape covering the new land. Apply pressure and heat as recommended in the manual of the repair system or repair kit. (See Figure 3).

10. After the bonding cycle remove the tape used for alignment. The film is fully cured. Carefully clean the area and inspect the land.

    NOTE
    Double sided and multilayer printed wiring boards, may require an eyelet to restore the through connection. Refer to section 5.0 Plated Hole Procedures.

11. Carefully remove any excess bonding film inside the plated hole using a ball mill or drill bit. Turn the ball mill or drill bit by hand to prevent damage to the wall of the plated through hole.

12. Install the proper component and solder in place.

    NOTE
    This method is used to repair a lifted land, but the repaired land may not have an intermetallic connection to the remaining plated hole. The solder joint of the replaced component will restore the integrity of the electrical connection or an eyelet or buss wire may be used. See Plated Hole Repair Procedures.

13. Replace surface coating to match prior coating as required.

EVALUATION

1. Visual examination and tape test per IPC-TM-650, Test Method 2.4.1.
2. Electrical tests as applicable.

NOTES



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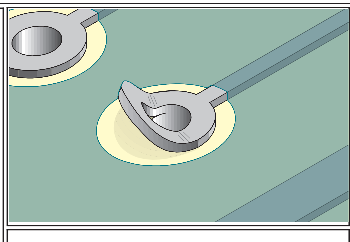
Repair and Modification of Printed Boards and Electronic Assemblies

Revision:

Date: **2/98**

Number: **4.5.1**

Land Repair, Epoxy Method



Product Class: R, F
Skill Level: Advanced
Level of Conformance: Medium

OUTLINE

This method is used to replace damaged and lifted lands. The damaged lands are replaced with new lands. The new lands are bonded to the printed wiring board surface using a commercially available epoxy.

CAUTION

This method is used to replace a damaged or missing land, but the new land will not have an intermetallic connection to the remaining plated hole. The solder joint of the replaced component will restore the electrical connection. If a component is not installed, a wire clinched to both sides of the printed wiring board may be used.

CAUTION

It is essential that the board surface be smooth and flat. If the base board is damaged see appropriate procedure.

NOTE

This method uses commercially available replacement lands. The new lands are fabricated from copper foil. They are available in hundreds of sizes and shapes and are generally supplied solder plated. If a special size or shape is needed they can be custom fabricated.

REFERENCES

2.1 Handling Electronic Assemblies
2.2 Cleaning
2.5 Baking and Preheating
2.6 Epoxy Mixing and Handling

TOOLS & MATERIALS

Ball mills or drills	Microscope
Buffer	Replacement Lands
Cleaner	Scraper
Epoxy	Solder
Heat Lamp	Soldering Iron
Polyimide Tape	Tweezers
Knife	Wipes
Liquid Flux	

PROCEDURE

1. Clean the area.
2. Remove the defective land and a short length of the connecting conductor if any. (See Figure 1.)

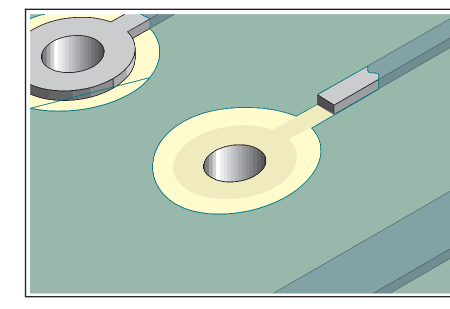


Figure 1 Remove the defective land and solder resist from the conductor.

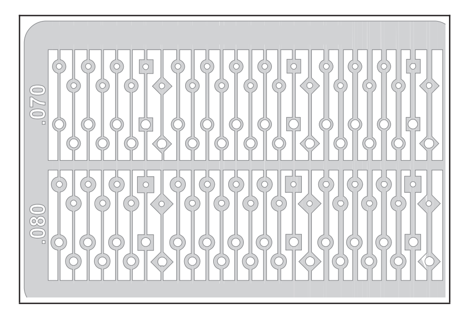


Figure 2 Select a replacement land that matches the missing land.

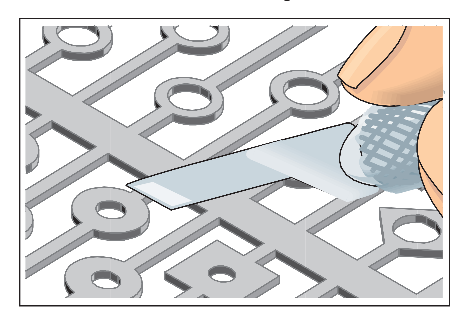


Figure 3 Cut out the replacement land.

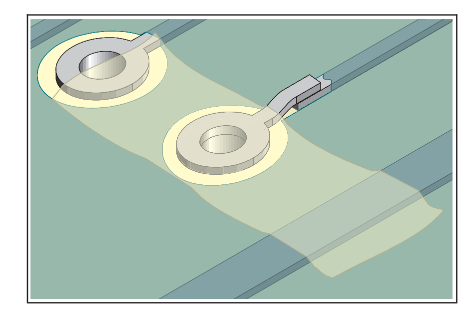


Figure 4 Place the new land in place using tape.

3. Use the knife and scrape off any epoxy residue, contamination or burned material from the board surface.

   CAUTION

   Abrasion operations can generate electrostatic charges.

4. Scrape off any solder resist or coating from the connecting conductor. (See Figure 1.)
5. Clean the area.
6. Apply a small amount of liquid flux to the connection area on the board surface and tin with solder. Clean the area. The length of the overlap solder connection should be a minimum of 2 times the conductor width.
7. The area for the new pad on the board surface must be smooth and flat. If internal fibers of the board are exposed or if there are deep scratches in the surface they should be repaired. Refer to appropriate procedure.
8. Select a replacement land that most closely matches the land to be replaced. (See Figure 2.)
9. Cut out and trim the new land. Cut the length to provide the maximum allowable conductor overlap for soldering. Minimum 2 times the conductor width. (See Figure 3.)

   NOTE

   The new replacement land may be trimmed from copper sheet.

10. Mix the epoxy and apply a small amount to the surface where the new land will be placed.
11. Place a piece of Polyimide tape over the top surface of the land. Place the new land into position on the printed wiring board surface using the tape to aid in alignment. (See Figure 4.)
12. Cure the epoxy per the manufacturer's instructions.
13. After the epoxy has cured, remove the tape used for the alignment. Carefully clean the area and inspect the new land for proper alignment.

    NOTE

    If the configuration permits, the overlap solder joint connection should be a minimum of 3.00 mm from the related termination. This gap will minimize the possibility of simultaneous reflow during soldering operations.

14. Remove tape and clean the area.
15. Mix the epoxy and coat the lap solder joint connections. Cure the epoxy per the manufacturer's recommended instructions.

    NOTE

    Additional epoxy can be applied around the perimeter of the new land to provide additional bond strength.

    CAUTION

    Some components may be sensitive to high temperature.

16. Carefully remove any excess epoxy inside the plated hole using a ball mill or drill bit. Turn the ball mill or drill bit by hand to prevent damage to the wall of the plated through hole.

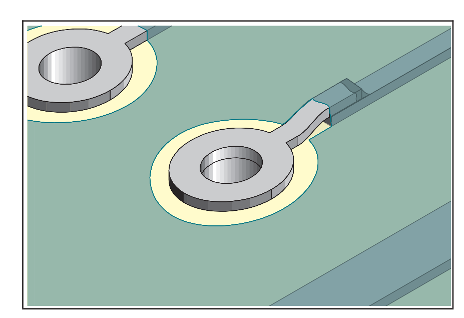


Figure 5 Completed repair.

17. Install the proper component and solder in place.

    NOTE

    This method is used to replace a damaged or missing lands, but the new land will not have an intermetallic connection to the remaining plated hole. The solder joint of the replaced component will restore the integrity of the electrical connection or an eyelet or clinched buss wire may be used. See Plated Hole Repair Procedures.

18. Apply surface coating to match prior coating as required.

EVALUATION

1. Visual examination
2. Measurement of new pad width and spacing.
3. Electrical continuity measurement.

NOTES



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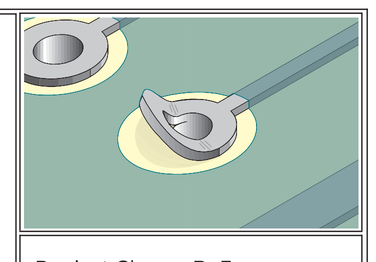
Repair and Modification of Printed Boards and Electronic Assemblies

Revision:

Number: **4.5.2**

Date: **2/98**

Land Repair, Film Adhesive Method



Product Class: R, F

Skill Level: Advanced

Level of Conformance: High

OUTLINE

This method is used to replace damaged and lifted lands. The damaged lands are replaced with new dry film, adhesive backed lands. The new lands are bonded to the printed wiring board surface using a bonding press or bonding iron.

CAUTION

This method is used to replace a damaged or missing land, but the new land will not have an intermetallic connection to the remaining plated hole. The solder joint of the replaced component will restore the integrity of the electrical connection. If a component is not installed, a wire clinched to both sides of the printed wiring board may be used.

CAUTION

It is essential that the board surface be smooth and flat. If the base board is damaged see appropriate procedure.

NOTE

This method uses commercially available replacement lands. The new lands are fabricated from copper foil and have a dry film adhesive coating on the back. They are available in hundreds of sizes and shapes and are generally supplied solder plated. If a special size or shape is needed they can be custom fabricated.

REFERENCES

2.1 Handling Electronic Assemblies
2.2 Cleaning
2.5 Baking and Preheating
2.6 Epoxy Mixing and Handling

TOOLS & MATERIALS

Bonding Iron	Liquid Flux
Bonding System	Microscope
Bonding Tips	Replacement Lands, Adhesive Backed
Buffer	Scraper
Cleaner	Solder
Epoxy	Soldering Iron
Heat Lamp	Tweezers
Polyimide Tape	Wipes
Knife	

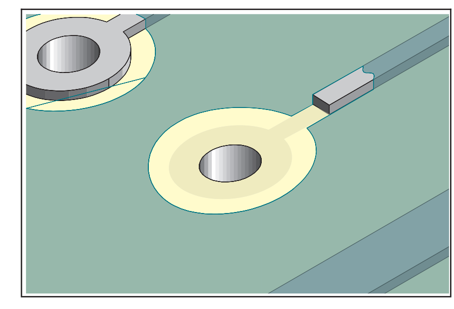


Figure 1 Remove the defective land and solder resist from the conductor.

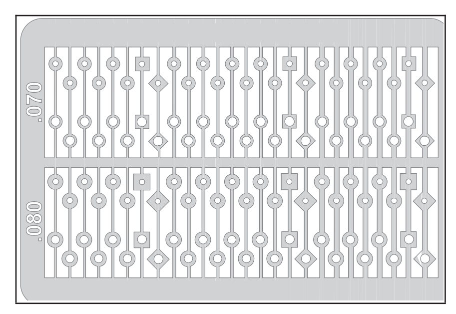


Figure 2 Select a replacement land that matches the missing land.

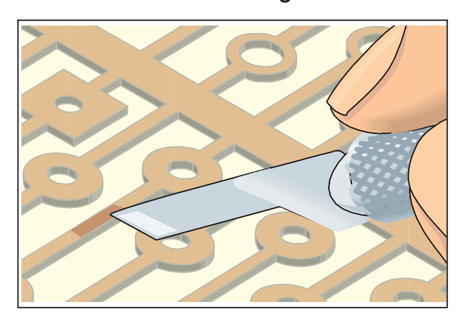


Figure 3 Scrape off the adhesive bonding film from solder joint area.

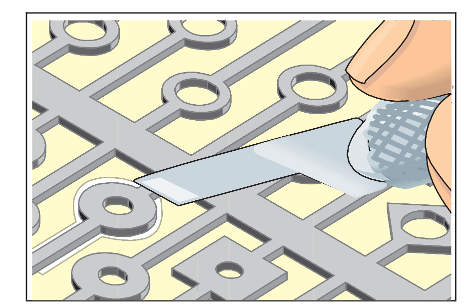


Figure 4 Cut out the new land.

Number: **4.5.2**

Subject: **Land Repair, Film Adhesive Method**

Revision:

Date: 2/98

PROCEDURE

1. Clean the area.
2. Remove the defective land and a short length of the connecting conductor if any. (See Figure 1.)
3. Use the knife and scrape off any epoxy residue, contamination or burned material from the board surface.

   CAUTION

   Abrasion operations can generate electrostatic charges.
4. Scrape off any solder resist or coating from the connecting conductor. (See Figure 1.)
5. Clean the area.
6. Apply a small amount of liquid flux to the connection area on the board surface and tin with solder. Clean the area. The length of the overlap solder connection should be a minimum of 2 times the conductor width.
7. The area for the new pad on the board surface must be smooth and flat. If internal fibers of the board are exposed or if there are deep scratches in the surface they should be repaired. Refer to appropriate procedure.
8. Select a replacement land that most closely matches the land to be replaced. (See Figure 2.)

   NOTE

   The new replacement land may be trimmed from copper sheet.
9. Before trimming out the new land carefully scrape off the adhesive film from the solder joint connection area on the back of the new land. (See Figure 3.)

   CAUTION

   Scrape off the epoxy backing only from the joint connection area. When handling the replacement land avoid touching the adhesive backing with your fingers or other materials that may contaminate the surface and reduce the bond strength.
10. Cut out and trim the new land. Cut out from the plated side. Cut the length to provide the maximum allowable conductor overlap for soldering. Minimum 2 times the conductor width. (See Figure 4.)
11. Place a piece of tape over the top surface of the new land. Place the new land into position on the printed wiring board surface using the tape to aid in alignment. Leave the tape in place during the bonding cycle. (See Figure 5.)
12. Select a bonding tip with a shape to match the shape of the new land.

    NOTE

    The Bonding Tip should be as small as possible but should completely cover the entire surface of the new land.
13. Position the printed wiring board so that it is flat and stable. Gently place the hot bonding tip onto the tape covering the new land. Apply pressure as recommended in the manual of the repair system or repair kit of the manufacturer. (See Figure 6.)

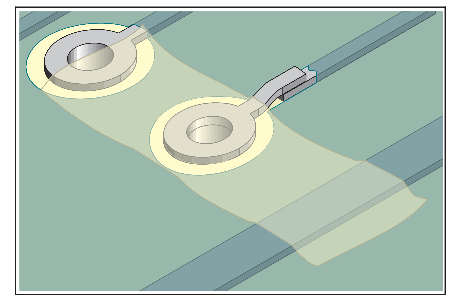


Figure 5 Place the new land in place using tape.



Figure 6 Bonding systems.

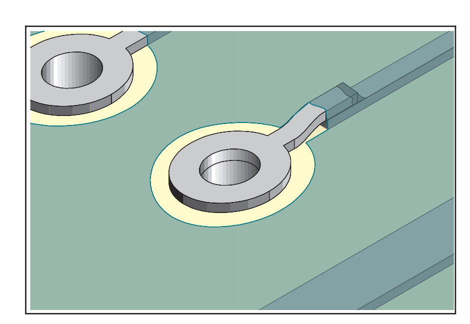


Figure 7 Completed land repair.

CAUTION
Excessive bonding pressure may cause measling in the printed wiring board surface or the new conductor to slide out of position.

14. After the bonding cycle remove the tape used for alignment. The land is fully cured. Carefully clean the area and inspect the new land for proper alignment.
15. If the new land has a connecting conductor apply a small amount of liquid flux to the lap solder joint connection area and solder the conductor from the new land to the conductor on the printed wiring board surface. Use minimal flux and solder to ensure a reliable connection. Tape may be placed over the top of the new land to prevent excess solder overflow.

NOTE
If the configuration permits, the overlap solder joint connection should be a minimum of 3.00 mm from the related termination. This gap will minimize the possibility of simultaneous reflow during soldering operations.

16. Remove tape and clean the area.
17. Mix epoxy and coat the lap solder joint connections. Cure the epoxy per the manufacturers instructions.

NOTE
Additional epoxy can be applied around the perimeter of the new pad to provide additional bond strength.

CAUTION
Some components may be sensitive to high temperature.

18. Carefully remove any excess bonding film inside the plated hole using ball mill or drill bit. Turn the ball mill or drill bit by hand to prevent damage to the wall of the plated through hole.
19. Install the proper component and solder in place.

NOTE
This method is used to replace a damaged or missing land, but the new land will not have an intermetallic connection to the remaining plated hole. The solder joint of the replaced component will restore the integrity of the electrical connection or an eyelet or buss wire may be used. See Plated Hole Repair Procedures.

20. Apply surface coating to match prior coating as required.

EVALUATION

1. Visual examination.
2. Measurement of new pad width and spacing.
3. Electrical continuity measurement.

Number: **4.5.2**	Subject: **Land Repair, Film Adhesive Method**
Revision: Date: 2/98	

NOTES



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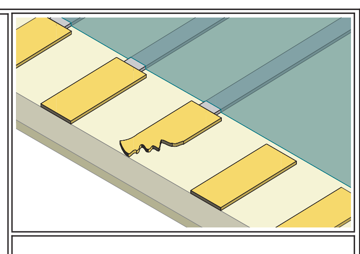
Repair and Modification of Printed Boards and Electronic Assemblies

Revision:

Date: **2/98**

Number: **4.6.1**

Edge Contact Repair, Epoxy Method



Product Class: R, F, W, C
Skill Level: Advanced
Level of Conformance: Medium

OUTLINE

This method is used to replace a damaged edge contact with a new edge contact. The new edge contact is bonded to the printed wiring board surface using liquid epoxy.

CAUTION

It is essential that the board surface be smooth and flat. If the base material is damaged see appropriate procedure.

NOTE

This method uses commercially available replacement edge contacts. The edge contacts are fabricated from copper foil. They are available in hundreds of sizes and shapes and are generally supplied either plain copper, solder plated or nickel and gold plated. If a special size or shape is needed they can be custom fabricated.

REFERENCES

2.1 Handling Electronic Assemblies
2.2 Cleaning
2.5 Baking And Preheating
2.6 Epoxy Mixing and Handling

TOOLS & MATERIALS

Cleaner	Oven
Epoxy	Replacement Edge Contacts
File, Finish Grade	Scraper
Heat Lamp	Solder
Polyimide Tape	Soldering Iron
Knife	Tweezers
Liquid Flux	Wipes
Microscope	

PROCEDURE

1. Clean the area.
2. Remove the defective edge contact and a short length of the connecting conductor. Heat from a soldering iron will allow the old contact to be removed more easily.
3. Use the knife and scrape off any epoxy residue, contamination or burned material from the board surface.

   CAUTION
   Abrasion operations can generate electrostatic charges.

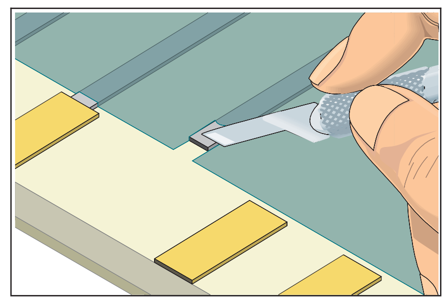


Figure 1 Remove the defective edge contact and solder resist.

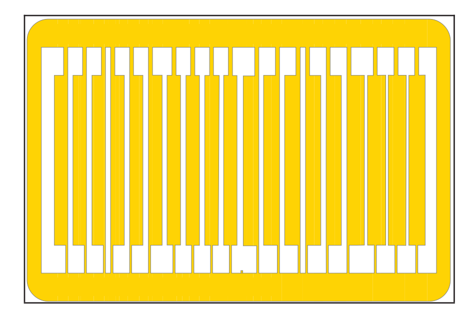


Figure 2 Select a replacement contact that matches.

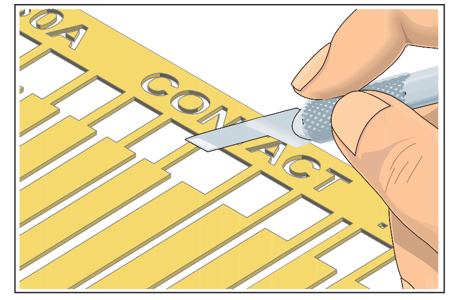


Figure 3 Cut out the new edge contact.

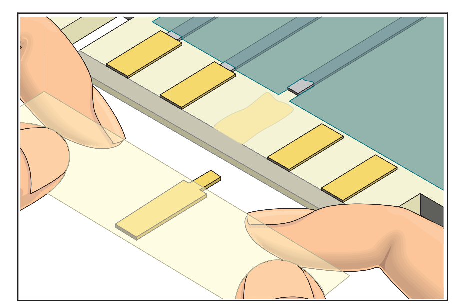


Figure 4 Place the new edge contact in place using tape.



4. Scrape off any solder resist or coating from the connecting conductor. (See Figure 1.)
5. Clean the area.
6. Apply a small amount of liquid flux to the connection area on the board surface and tin with solder. Clean the area. The length of the overlap solder connection should be a minimum of 2 times the conductor width.
7. The area for the new edge contact on the board surface must be smooth and flat. If internal fibers of the board are exposed or deep scratches exist in the surface they should be repaired. Refer to appropriate procedure.
8. Select a new edge contact that most closely matches the edge contact to be replaced. (See Figure 2.)
9. Cut out and trim the new edge contact. Cut out from the plated side. Cut the length to provide the maximum allowable joint if lap soldering. Minimum 2 times the conductor width. Leave the new edge contact extra long. The excess material will be trimmed after curing. (See Figure 3.)

   NOTE
   The new replacement edge contact may be trimmed from copper sheet.
10. Mix the epoxy and apply a small amount to the surface where the new contact will be placed.
11. Place a piece of tape over the top surface of the new edge contact. Position the new edge contact on the printed wiring board surface using the tape to aid in alignment. (See Figure 4.)

    NOTE
    Allow the edge contact to overhang the edge of the printed wiring board. Leave the tape in place during the bonding cycle.
12. Cure the epoxy per the manufacturer's instructions.

    CAUTION
    Some components may be sensitive to high temperature.
13. After the epoxy has cured, remove the tape used for alignment. Carefully clean and inspect the new pad for proper alignment.

    NOTE
    Additional epoxy can be applied around the perimeter of the new edge contact to provide additional bond strength.
14. If the new edge contact has a connecting conductor apply a small amount of liquid flux to the lap solder joint connection area and solder the conductor from the new edge contact to the conductor on the printed wiring board surface. Use minimal flux and solder to ensure a reliable connection. Tape may be placed over the top of the new edge contact to prevent excess solder overflow.

    NOTE
    If the configuration permits, the overlap solder joint connection should be a minimum of 3.00 mm from the related termination. This gap will minimize the possibility of simultaneous reflow during soldering operations.
15. Remove the tape and clean the area.

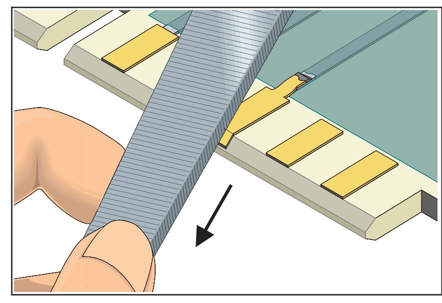


Figure 5 File overhanging piece of new edge contact.

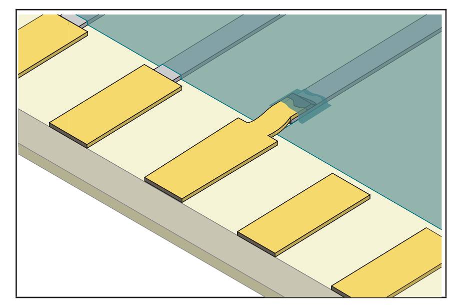


Figure 6 Completed repair.

16. Trim the extending edge of the new edge contact with a file. File parallel to the beveled edge until the excess material has been removed. (See Figure 5.)
17. If sealing the lap solder joint connection is required, mix epoxy and coat the lap solder joint connections. Cure the epoxy per the manufacturer's instructions.
18. If plating is required refer to appropriate procedure.
19. Apply surface coating to match prior coating as required.

EVALUATION

1. Visual examination, measurement of new pad width and spacing.
2. Electrical continuity measurement.

Number: **4.6.1**	Subject: **Edge Contact Repair, Epoxy Method**
Revision: Date: 2/98	

NOTES



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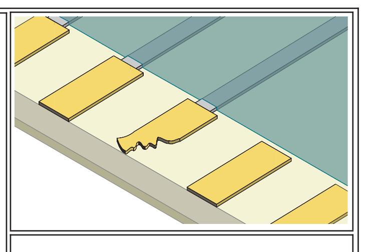
Repair and Modification of Printed Boards and Electronic Assemblies

Revision:

Date: **2/98**

Number: **4.6.2**

Edge Contact Repair, Film Adhesive Method



Product Class: R, F, W, C
Skill Level: Advanced
Level of Conformance: High

OUTLINE

This method is used to replace a damaged edge contact with a new dry film, adhesive backed edge contact. The new edge contact is hot bonded to the printed wiring board surface.

CAUTION

It is essential that the board surface be smooth and flat. If the base material is damaged see appropriate procedure.

NOTE

This method uses commercially available replacement edge contacts. The edge contacts are fabricated from copper foil and have a dry film adhesive coating on the back. They are available in hundreds of sizes and shapes and are generally supplied nickel and gold plated. If a special size or shape is needed they can be custom fabricated.

REFERENCES

2.1 Handling Electronic Assemblies
2.2 Cleaning
2.5 Baking and Preheating
2.6 Epoxy Mixing and Handling

TOOLS & MATERIALS

Bonding Iron
Bonding System
Bonding Tips
Cleaner
Epoxy
File, Finish Grade
Heat Lamp
Polyimide Tape
Knife
Liquid Flux
Microscope
Oven
Replacement Edge Contacts, Adhesive Backed
Scraper
Solder
Soldering Iron
Tweezers
Wipes

PROCEDURE

1. Clean the area.
2. Remove the defective edge contact and a short length of the connecting conductor. Heat from a soldering iron will allow the old contact to be removed more easily.

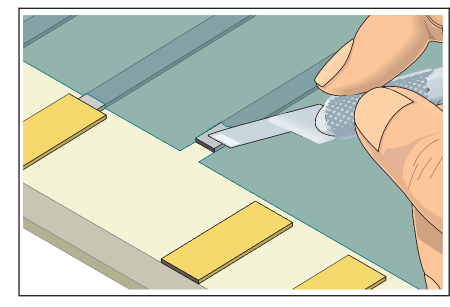


Figure 1 Remove the defective edge contact and solder resist.

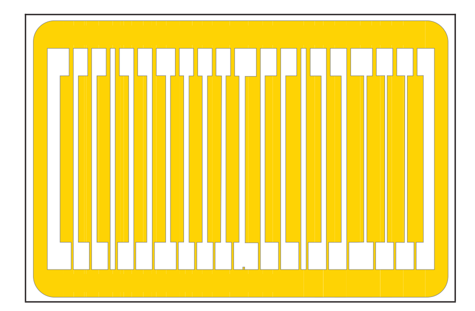


Figure 2 Select a replacement contact that matches.

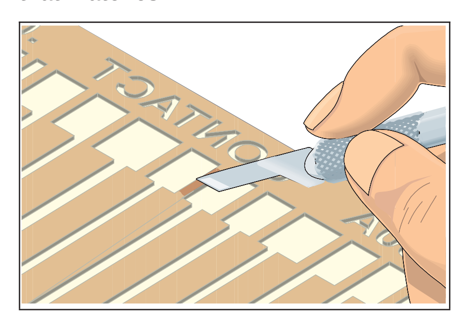


Figure 3 Scrape off adhesive bonding film from solder joint area.

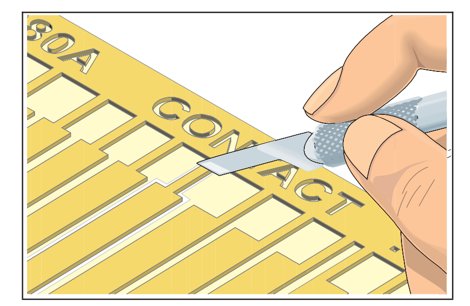


Figure 4 Cut out the new edge contact.

3. Use the knife and scrape off any epoxy residue, contamination or burned material from the board surface.

   CAUTION
   Abrasion operations can generate electrostatic charges.

4. Scrape off any solder resist or coating from the connecting conductor. (See Figure 1.)
5. Clean the area.
6. Apply a small amount of liquid flux to the connection area on the board surface and tin with solder. Clean the area. The length of the overlap solder connection should be a minimum of 2 times the conductor width.
7. The area for the new edge contact on the board surface must be smooth and flat. If internal fibers of the board are exposed or deep scratches exist in the surface they should be repaired. Refer to appropriate procedure.
8. Select a new edge contact that most closely matches the edge contact to be replaced. (See Figure 2.)

   NOTE
   The new replacement edge contact may be trimmed from copper sheet.

9. Before trimming out the new edge contact carefully scrape off the adhesive film from the solder joint connection area on the back of the new edge contact. (See Figure 3.)

   CAUTION
   Scrape off the epoxy backing only from the joint connection area. When handling the replacement contact, avoid touching the epoxy backing with your fingers or other materials that may contaminate the surface and reduce the bond strength.

10. Cut out and trim the new edge contact. Cut out from the plated side. Cut the length to provide the maximum allowable joint if lap soldering. Minimum 2 times the conductor width. Leave the new edge contact extra long. The excess material will be trimmed after bonding. (See Figure 4.)
11. Place a piece of tape over the top surface of the new edge contact. Position the new edge contact on the printed wiring board surface using the tape to aid in alignment. (See Figure 5.)

    NOTE
    Allow the edge contact to overhang the edge of the printed wiring board. Leave the Tape in place during the bonding cycle.

12. Select a bonding tip with a shape to match the shape of the new edge contact.

    NOTE
    The bonding tip should be as small as possible but completely cover the entire surface of the new edge contact.

13. Position the printed wiring board so that it is flat and stable. Gently place the hot bonding tip onto the tape covering the new edge contact. Apply pressure as recommended by the manufacturer. (See Figure 6.)

    CAUTION
    Excessive bonding pressure may cause measling in the printed wiring board surface or the new conductor to slide out of position.

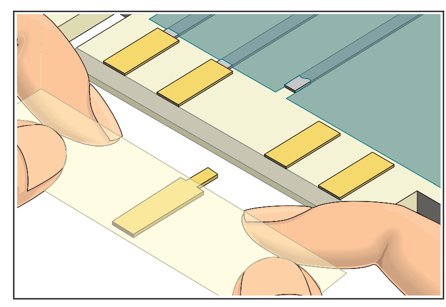


Figure 5 Place the new edge contact in place using tape.



Figure 6 Bonding system.

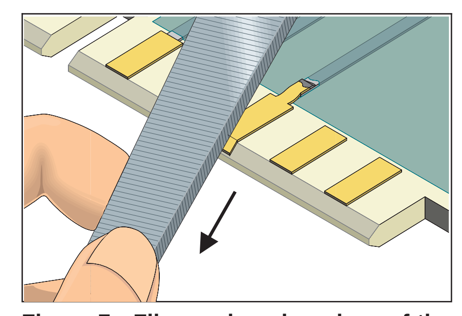


Figure 7 File overhanging piece of the new edge contact.

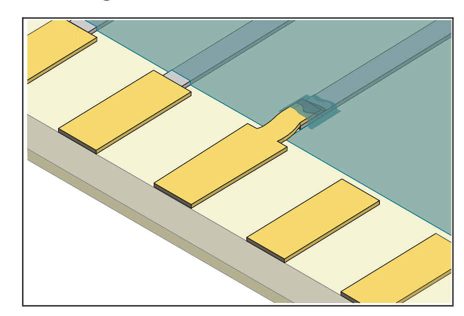


Figure 8 Completed repair.

14. After the bonding cycle remove the tape used for alignment. The new edge contact is fully cured. Carefully clean the area and inspect the new edge contact for proper alignment.
15. If the new edge contact has a connecting conductor apply a small amount of liquid flux to the lap solder joint connection area and solder the conductor from the new edge contact to the conductor on the printed wiring board surface. Use minimal flux and solder to ensure a reliable connection. Tape may be placed over the top of the new edge contact to prevent excess solder overflow.

    NOTE

    If the configuration permits, the overlap solder joint connection should be a minimum of 3.00 mm from the related termination. This gap will minimize the possibility of simultaneous reflow during soldering operations.
16. Remove tape and clean the area.
17. Trim the extending edge of the new edge contact with a file. File parallel to the beveled edge until the excess material has been removed. (See Figure 7.)
18. If sealing the lap solder joint connection is required, mix epoxy and coat the lap solder joint connections. Cure the epoxy per the manufacturer's instructions.

    CAUTION

    Some components may be sensitive to high temperature.

    NOTE

    Additional epoxy can be applied around the perimeter of the new edge contact to provide additional bond strength.
19. Apply surface coating to match prior coating as required.

EVALUATION

1. Visual examination, measurement of new pad width and spacing.
2. Electrical continuity measurement.

Number: **4.6.2**	Subject: **Edge Contact Repair, Film Adhesive Method**
Revision: Date: 2/98	

NOTES



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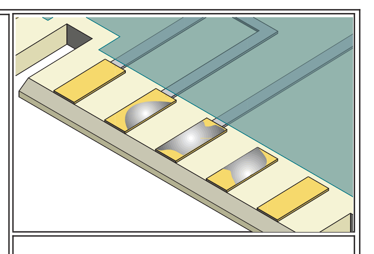
Repair and
Modification of
Printed Boards and
Electronic Assemblies

Revision:

Date: **2/98**

Number: **4.6.3**

Edge Contact Repair, Plating Method



Product Class: R, F, W, C
Skill Level: Advanced
Level of Conformance: High

OUTLINE

This method is used to replate edge contacts by selective swab plating. Edge contacts may require replating if they become contaminated with solder or are scratched during handling. Other applications may arise when the plating on the edge contacts does not meet the minimum thickness specification or if the specification changes.

This electroplating process uses a DC power supply. One lead is connected to the connector edge contacts that need plating. A second lead is connected to the plating probe. The plating probe has an anode fastened to the tip. The anode has absorbent wrapping. The anode is dipped into high-speed proprietary plating solutions. When the saturated anode is swabbed across the printed wiring board connector edge contacts, the metal contained in the solution is plated wherever electrical contact is made. Prior to replating any solder contamination must be removed.

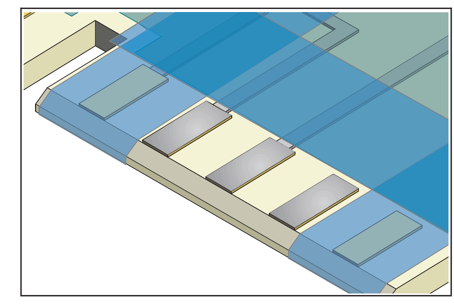


Figure 1 Apply tape.



CAUTION

This method can be used to replate any metal surface including connector edge contacts, but it is essential that the surface to be plated is free of deep scratches, nicks, pin holes or other defects. If the edge contacts need to be replaced see appropriate procedure.

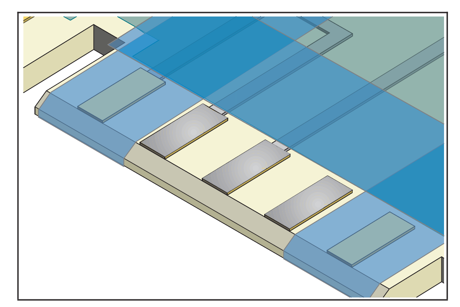


Figure 2 Flow solder.

SAFETY

A thorough review of this method should be made before repairs are attempted. Technicians should become familiar with the tools included and should practice on scrap printed wiring boards

To expect the best results a clean work environment is essential. A smooth work surface and good lighting are recommended. Safety glasses and safety gloves should always be worn when handling hazardous chemicals.

The work area should be adequately ventilated. It is particularly important to have adequate ventilation when using gold solution, since gold solution contains a very small percentage of free cyanide. If ventilation is not adequate, use a fan to move fumes away from the operator.

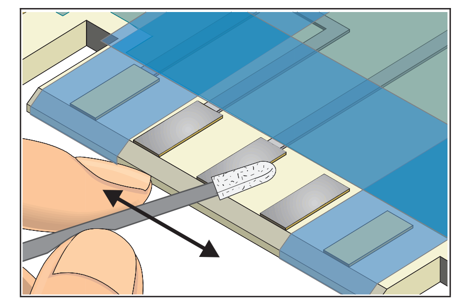


Figure 3 Solder stripping solution.

CAUTION

It is essential to follow the manufacturer's instructions supplied with the plating equipment.

REFERENCES

2.1 Handling Electronic Assemblies
2.2 Cleaning

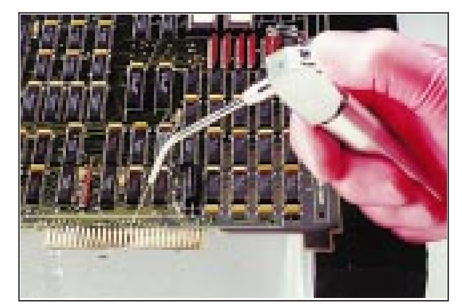


Figure 4 Rinse.

Number: **4.6.3**

Subject: **Edge Contact Repair, Plating Method**

Revision:

Date: 2/98

TOOLS & MATERIALS

Abrasive Pad
Board Support
Burnisher
Cleaner
Cleaner Wipes
Connector Edge Plating System
Conductive Pen
Desoldering Braid or Desoldering System
Eraser Stick
Gloves, Antistatic
Polyimide Tape
Knife
Liquid Flux
Peel Testing Tape
Pin Fixtures
Plating Anodes
Plating Cables
Plating Probe
Plating Solution, Gold
Plating Solution, Nickel
Plating Solution, Electroclean
Plating Solution, Solder Strip
Plating Tape
Power Supply
Probe Clip
Rinse Bottle
Rinse Tray
Safety Glasses
Solder
Solder Iron
Solution Cups
Solution Tray
Swab
Thickness Measuring System, Gold and Nickel
Water/Air Sprayer
Wire, Buss, 30 AWG
Work Sink

PREPARATION − Remove Solder Contamination

CAUTION

Safety glasses and safety gloves should always be worn when handling hazardous chemicals. Do not work within a small enclosed room without supplemental ventilation. If ventilation is not adequate, use a fan to move fumes away from the operator.

1. Clean the rework area.
2. Apply plating tape to the printed wiring board surface surrounding the area to be reworked. (See Figure 1.) The plating tape will protect adjacent components and the printed wiring board surface from unwanted exposure to stripping and plating solutions.
3. Flow solder over the entire area of any contacts that have contamination using a soldering iron. This provides a more even surface when plating. Remove the bulk of the solder contamination using desoldering tools or desoldering braid. (See Figure 2.)
4. Clean the area.
5. Place the printed wiring board on the board support so that the leading edge overhangs the rinse tray.
6. Swab the solder stripping solution over the solder contamination using a swab. Swab the surface until all remaining solder has been stripped off. (See Figure 3.)
7. Thoroughly rinse the entire area with water. (See Figure 4.)
8. Mildly buff the contacts using abrasive pad. Mild buffing will prepare the surface for plating and remove any remaining solder contamination.
9. Thoroughly rinse with water to remove any residue.

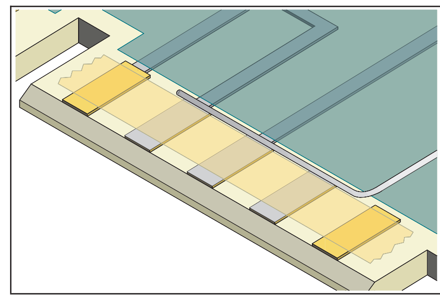


Figure 5 Solder a wire to the edge of the contacts needing plating.

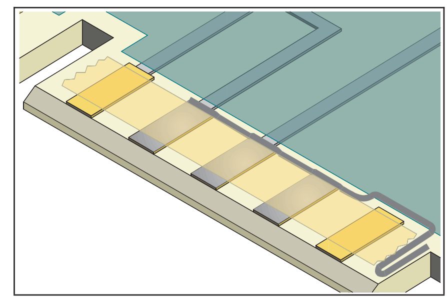


Figure 6 Apply conductive paint to the edge of the contacts.

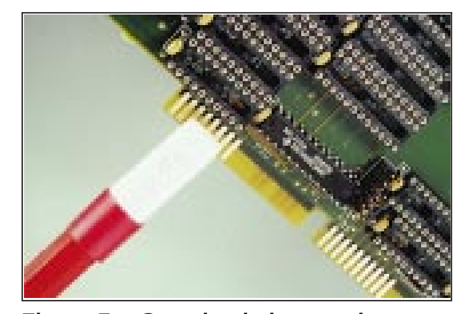


Figure 7 Sample plating anodes shown with fabric wrapping.

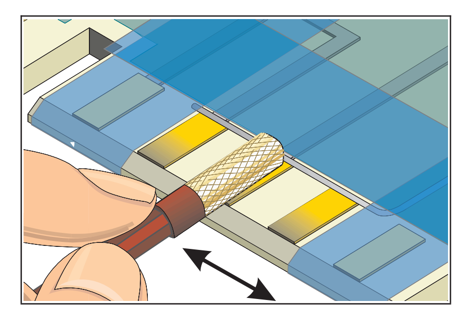


Figure 8 Brush the surface with the saturated plating probe.

PREPARATION − Remove Poor Plating or Surface Defects

1. Clean the rework area.
2. Apply plating tape to the printed wiring board surface surrounding the area to be reworked. The plating tape will protect adjacent components and the printed wiring board surface from unwanted exposure to stripping and plating solutions.
3. Clean the area.
4. Buff the contacts using an abrasive pad. Buff the contacts until all defective or poor plating is removed.
5. Burnish small scratches. Use the tip of the burnisher to work the copper material into the scratch and smooth out the area. Finish by mildly buffing the area to remove any minor burnishing marks. If there are large scratches the contact may need replacement. See Procedure Number 4.6.1 or 4.6.2.
6. Thoroughly rinse the entire area with water to remove any residue.

BUSSING

A conductive buss must be made to all the contacts that need plating. There are 4 basic connection options.

NOTE
Making a reliable buss connection is the most important step in plating. All sorts of problems will be eliminated by taking the time to make a reliable buss connection.

BUSSING − Wire Soldered to Edge (Option 1)

CAUTION
When finished, this method will leave a small unplated line along the inner tip of each contact.

1. Apply Polyimide tape to all the contacts to be plated. The tape should cover the entire contact except for a small line along the inboard edge. The tape will prevent further solder contamination.
2. Solder a wire directly to the inboard tip or connecting conductor of each contact to be plated. The smallest amount of solder should be used to prevent further contamination. (See Figure 5.)

BUSSING − Conductive Paint Applied to Edge (Option 2)

CAUTION
When finished, this method will leave a small unplated line along the inner tip of each contact.

1. Apply Polyimide tape to all the contacts to be plated. The tape should cover the entire contact except for a small line along the inboard edge. The tape will prevent the conductive paint from contaminating the contact surface.
2. Apply a thin coating of conductive paint directly to the inboard tip of each contact to be plated. The conductive paint should extend out to one edge so that a clip can be applied to make electrical connection. (See Figure 6.)

BUSSING − Mechanical Probe, Individual Contacts (Option 3)

1. Each contact needing plating can be individually probed using the plating probe. Touch the tip of the plating probe to the inboard edge of each contact or to the connecting conductor as each solution is applied during the plating process.

BUSSING − Pin Fixture, Multiple Contacts (Option 4)

1. Make a mechanical connection to each contact using a pin fixture. The pin fixture has spring loaded contact pins on centers matching the spacing of the edge contacts to be plated. The contact pins make direct mechanical connection to the inboard tip of each contact, the connecting conductor trace or a connecting plated through hole.

PROCEDURE − Plating Process

1. Place the printed wiring board on the board support so that the leading edge overhangs the rinse tray.
2. Make the cathode connection (-) to the printed wiring board by using a plating probe or probe clip. Connect the probe clip directly to the wire buss connection or to the edge where conductive paint has been applied. The cable should be connected to the (-) or black jack on the power supply.
3. Connect the plating probe to the power supply (+) or red jack. (See Figure 7.)
4. Set the output current on the power supply to setting recommended by the equipment manufacturer.
5. Dip the plating probe into the electroclean plating solution. Wait a few seconds for the solution to saturate the absorbent wrapping.
6. Swab the entire surface to be plated by brushing the surface with the saturated plating probe. The plating probe should be moved back and forth briskly to prevent burning and to provide even coverage. (See Figure 8.) Swab the area for the time recommended by the equipment manufacturer.
7. Thoroughly rinse the entire area with water. Any burning or darkening of the contacts may be removed with an abrasive pad. Saturate the abrasive pad and the printed wiring board surface with water and lightly buff the contacts until all evidence of the burning or discoloring is removed. Rinse the entire area with water.

   CAUTION
   Do not allow the rework area to dry out between steps. The water coating prevents oxidation.
8. Connect the nickel plating probe to the power supply (+) or red jack.
9. Dip the plating probe into the nickel plating solution. Wait a few seconds for the solution to saturate the absorbent wrapping.
10. Swab the entire surface to be plated by brushing the surface with the saturated plating probe. The plating probe should be moved back and forth briskly to prevent burning and to provide even coverage. Swab the area for the time recommended by the equipment manufacturer. Before rinsing, lightly buff the contacts with an abrasive pad.

11. Thoroughly rinse the entire area with water.
12. Connect the gold plating probe to the power supply (+) or red jack.
13. Dip the plating probe into the gold plating solution. Wait a few seconds for the solution to saturate the absorbent wrapping.
14. Swab the entire surface to be plated by brushing the surface with the saturated plating probe. The plating probe should be moved back and forth briskly to prevent burning and to provide even coverage. Swab the area for the time recommended by the equipment manufacturer.
15. Thoroughly rinse the entire area with water.
16. Remove and discard all plating tape and thoroughly rinse the area with water. Dry the area using a air sprayer or wipes.
17. Remove the wire or conductive paint used to buss the contacts.

    CAUTION

    Apply tape to protect the contacts from further contamination while removing the buss connection.

16. Thoroughly rinse the entire area with deionized water or rinse the printed wiring board in an aqueous water cleaning system.

EVALUATION

1. The rework area should be checked by measuring the thickness of the nickel and gold to make sure they meet the minimum thickness requirement.
2. The plating bond may also be checked by doing a peel test using peel testing tape.
3. Visually examine the rework area for color and luster.

NOTES



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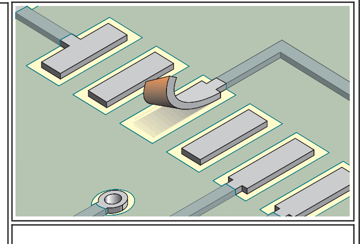
Repair and Modification of Printed Boards and Electronic Assemblies

Revision:

Date: **2/98**

Number: **4.7.1**

Surface Mount Pad Repair, Epoxy Method



Product Class: R, F, C

Skill Level: Advanced

Level of Conformance: Medium

OUTLINE

This method is used to replace damaged surface mount pads with commercially available replacement pads. The new pads are bonded to the printed wiring board surface using liquid epoxy.

CAUTION

It is essential that the board surface be smooth and flat. If the base material is damaged see appropriate procedure.

NOTE

This method uses commercially available replacement surface mount pads. The new pads are fabricated from copper foil. They are available in hundreds of sizes and shapes and are generally supplied solder plated. If a special size or shape is needed they can be custom fabricated.

REFERENCES

2.1 Handling Electronic Assemblies
2.2 Cleaning
2.5 Baking and Preheating
2.6 Epoxy Mixing and Handling

TOOLS & MATERIALS

Buffer	Oven
Cleaner	Replacement Surface Mount Pads
Epoxy	Scraper
Heat Lamp	Solder
Knife	Soldering Iron
Polyimide Tape	Tweezers
Liquid Flux	Wipes
Microscope	

PROCEDURE

1. Clean the area.
2. Remove the defective pad and a short length of the connecting conductor. (See Figure 1.)
3. Use a knife and scrape off any epoxy residue, contamination or burned material from the board surface.

   CAUTION
   Abrasion operations can generate electrostatic charges.
4. Scrape off any solder resist or coating from the connecting conductor. (See Figure 2.)

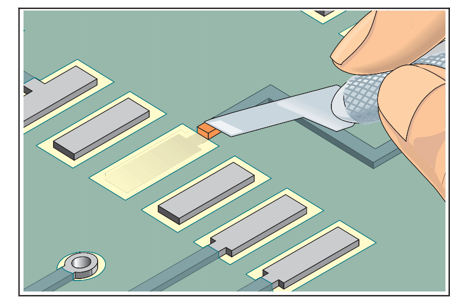


Figure 1 Remove pad.

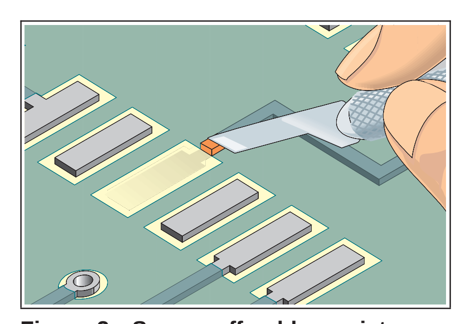


Figure 2 Scrape off solder resist.

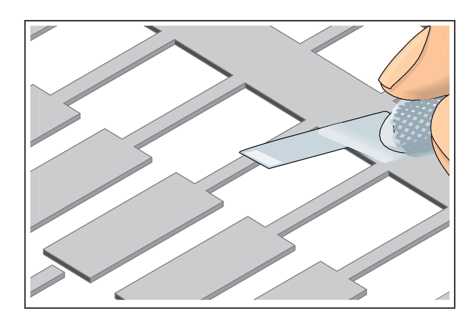


Figure 3 Cut out new pad.

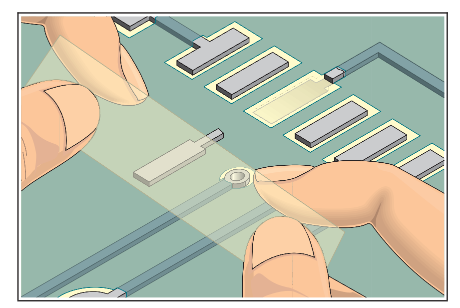


Figure 4 Position pad using tape.

5. Clean the area.
6. Apply a small amount of liquid flux to the connection area on the board surface and tin with solder. Clean the area. The length of the overlap solder connection should be a minimum of 2 times the conductor width.
7. The area for the new pad on the board surface must be smooth and flat. If internal fibers of the board are exposed or if there are deep scratches in the surface they should be repaired. Refer to appropriate procedure.
8. Select a commercially available surface mount pad that most closely matches the surface mount pad to be replaced. If a special size or shape is needed they can be custom fabricated.
9. Cut out and trim the new pad. Cut the length to provide the maximum allowable conductor overlap for soldering. Minimum 2 times the conductor width. (See Figure 3.)

   NOTE

   The new replacement surface mount pad may be trimmed from copper sheet.
10. Mix the epoxy and apply a small amount to the surface where the new pad will be placed.
11. Place a piece of Polyimide tape over the top surface of the new pad. Place the new pad into position on the printed wiring board surface using the tape to help in alignment. (See Figure 4.)
12. Cure the epoxy per the manufacturers instructions.

    CAUTION

    Some components may be sensitive to high temperature.
13. After the epoxy has cured remove the Polyimide tape used for alignment. Carefully clean the area and inspect the new pad for proper alignment.
14. If the new pad has a connecting conductor apply a small amount of liquid flux to the lap solder joint connection area and solder the conductor from the new pad to the conductor on the printed wiring board surface. Use minimal flux and solder to ensure a reliable connection. Tape may be placed over the top of the new pad to prevent excess solder overflow.

    NOTE

    If the configuration permits, the overlap solder joint connection should be a minimum of 3.00 mm from the related termination. This gap will minimize the possibility of simultaneous reflow during soldering operations.
15. Mix epoxy and coat the lap solder joint connections. Cure the epoxy per the manufacturers recommended instructions.

    NOTE

    Additional epoxy can be applied around the perimeter of the new pad to provide additional bond strength.
16. Apply surface coating to match prior coating as required.

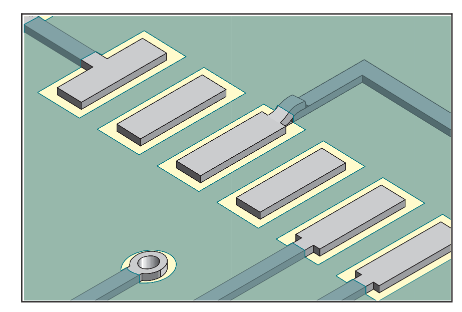


Figure 5 Completed repair.

EVALUATION

1. Visual examination
2. Measurement of new pad width and spacing.
3. Electrical continuity measurement.

NOTES



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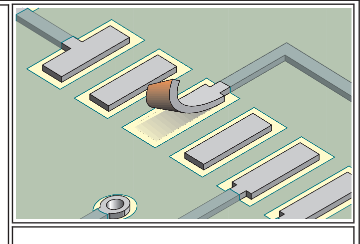
Repair and Modification of Printed Boards and Electronic Assemblies

Revision:

Date: **2/98**

Number: **4.7.2**

Surface Mount Pad Repair, Film Adhesive Method



Product Class: R, F, C
Skill Level: Advanced
Level of Conformance: High

OUTLINE

This method is used to replace damaged surface mount pads with new dry film, adhesive backed pads. The new pads are bonded to the printed wiring board surface using a specially designed bonding press or bonding iron.

CAUTION

It is essential that the board surface be smooth and flat. If the base material is damaged see appropriate procedure.

NOTE

This method uses commercially available replacement surface mount pads. The new pads are fabricated from copper foil. They are available in hundreds of sizes and shapes and are generally supplied solder plated. If a special size or shape is needed they can be custom fabricated.

REFERENCES

2.1 Handling Electronic Assemblies
2.2 Cleaning
2.5 Baking and Preheating
2.6 Epoxy Mixing and Handling

TOOLS & MATERIALS

Bonding Iron
Bonding System
Bonding Tips
Cleaner
Epoxy
Heat Lamp
Polyimide Tape
Knife
Liquid Flux
Microscope
Oven
Replacement Surface Mount Pads
Scraper
Solder
Soldering Iron
Tweezers
Wipes

PROCEDURE

1. Clean the area.
2. Remove the defective pad and a short length of the connecting circuit. (See Figure 1.)
3. Use a knife and scrape off any epoxy residue, contamination or burned material from the board surface.

   CAUTION
   Abrasion operations can generate electrostatic charges.

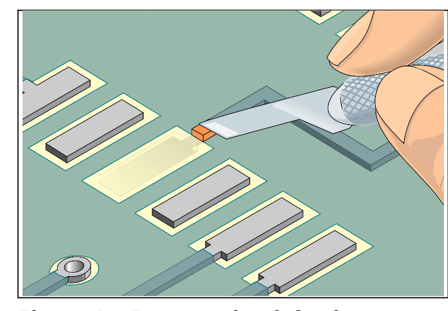


Figure 1 Remove the defective surface mount pad and soldermask.

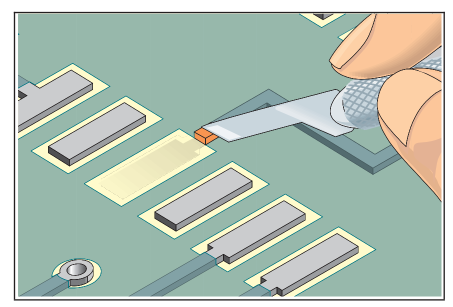


Figure 2 Scrape off solder resist.

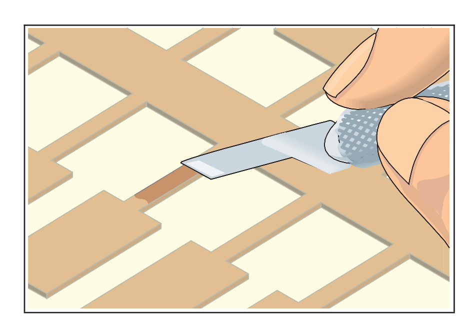


Figure 3 Scrape off the adhesive bonding film from solder joint area.

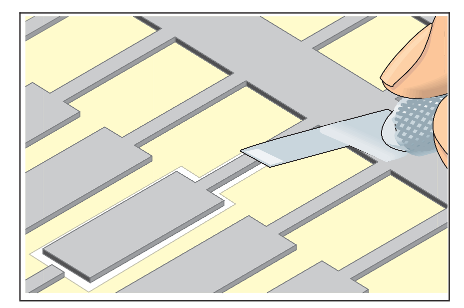


Figure 4 Cut out the new surface mount pad.

4. Scrape off any solder resist or coating from the connecting circuit. (See Figure 2.)
5. Clean the area.
6. Apply a small amount of liquid flux to the connection area on the board surface and tin with solder. Clean the area. The length of the overlap solder connection should be a minimum of 2 times the circuit width.
7. The area for the new pad on the board surface must be smooth and flat. If internal fibers of the board are exposed or if there are deep scratches in the surface, they should be repaired. Refer to appropriate procedure.
8. Select a commercially available surface mount pad that most closely matches the surface mount pad to be replaced. If a special size or shape is needed they can be custom fabricated.

   NOTE
   New surface mount pads are fabricated from copper foil. The foil is plated on the top side with solder and an adhesive bonding film is applied to the bottom side.

9. Before trimming out the new pad carefully scrape off the adhesive bonding film from the solder joint connection area on the back of the new pad. (See Figure 3.)

   CAUTION
   Scrape off the epoxy backing only from the joint connection area. When handling the replacement contact, avoid touching the epoxy backing with your fingers or other materials that may contaminate the surface and reduce the bond strength.

10. Cut out and trim the new pad. Cut out from the plated side. Cut the length to provide the maximum allowable circuit overlap for soldering. Minimum 2 times the circuit width. (See Figure 4.)
11. Place a piece of Polyimide tape over the top surface of the new pad. Place the new pad into position on the printed wiring board surface using the tape to help in alignment. Leave the tape in place during the bonding cycle. (See Figure 5.)
12. Select a commercially available bonding tip with a shape to match the shape of the new pad. See bonding tip chart in the replacement parts section of the manual provided with the repair system or repair kit.

   NOTE
   The tip used for bonding should be as small as possible but should completely cover the entire surface of the new pad.

13. Position the printed wiring board so that it is flat and stable. Gently place the hot bonding tip onto the tape covering the new pad. Apply pressure as recommended in the manual of the repair system or repair kit. (See Figure 6.)

   CAUTION
   Excessive bonding pressure may cause measling in the printed wiring board surface or may cause the new pad to slide out of position.

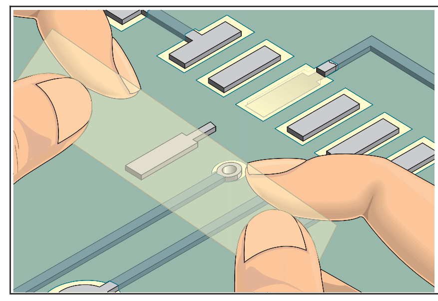


Figure 5 Place the new surface mount pad in place using tape.



Figure 6 Bonding system.

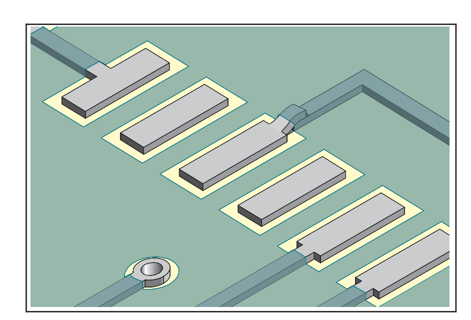


Figure 7 Completed repair.

14. After the timed bonding cycle lift the bonding iron and remove the tape used for alignment. The pad is fully cured. Carefully clean the area and inspect the new pad for proper alignment.
15. If the new pad has a connecting circuit apply a small amount of liquid flux to the lap solder joint connection area and solder the circuit from the new pad to the circuit on the printed wiring board surface. Use minimal flux and solder to ensure a reliable connection. Tape may be placed over the top of the new pad to prevent excess solder overflow.

    NOTE
    If the configuration permits, the overlap solder joint connection should be a minimum of 3.00 mm from the related termination. This gap will minimize the possibility of simultaneous reflow during soldering operations.
16. Mix epoxy and coat the lap solder joint connection. Cure the epoxy per the manufacturers recommended instructions.

    NOTE
    Additional epoxy can be applied around the perimeter of the new pad to provide additional bond strength.

    CAUTION
    Some components may be sensitive to high temperature.
17. Apply surface coating to match prior coating as required.

EVALUATION

1. Visual examination
2. Measurement of new pad width and spacing.
3. Electrical continuity measurement.

NOTES



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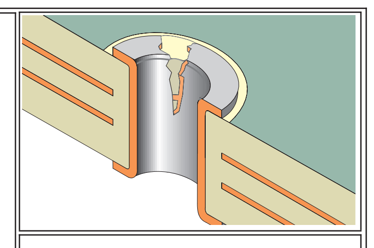
Repair and Modification of Printed Boards and Electronic Assemblies

Revision:

Date: **2/98**

Number: **5.1**

Plated Hole Repair, No Inner Layer Connection



Product Class: R, F, W
Skill Level: Intermediate
Level of Conformance: High

OUTLINE

This procedure covers the repair of a damaged hole that has no inner layer connection. An eyelet is used to repair the damage to the hole and the eyelet flanges replace the pads on the printed wiring board surface.

CAUTION

This procedure is used only to restore the integrity of a through connection in a double sided board or a multilayer board where there is no inner layer connection. If there is an inner layer connection see appropriate procedure.

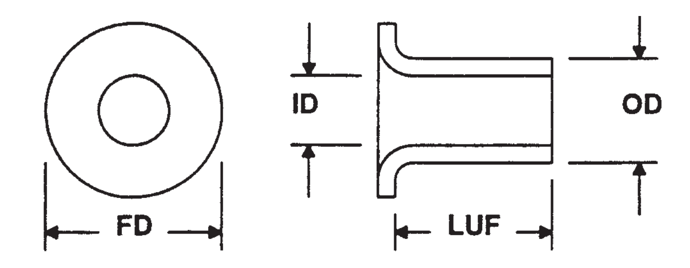
REFERENCES

2.1 Handling Electronic Assemblies
2.2 Cleaning

TOOLS & MATERIALS

Ball Mills, Carbide	Liquid Flux
Caliper	Knife
Cleaner	Microscope
Eyelets	Pin Gauges
Eyelet Press System	Solder
Eyelet Repair Kit	Solder Iron
Eyelet Setting Tools	Wipes
Hand Held Drill	

EYELET SELECTION CRITERIA



ID Inside Diameter

The eyelet inside diameter should be a 0.075 - 0.500 mm greater than the component lead diameter.

LUF Length Under Flange

The length of the eyelet barrel under the flange should be 0.630 - 0.890 mm greater than the thickness of the printed wiring board. This added length allows for proper protrusion when setting the eyelet.



Figure 1 Drill out the hole using a hand held drill and ball mill.

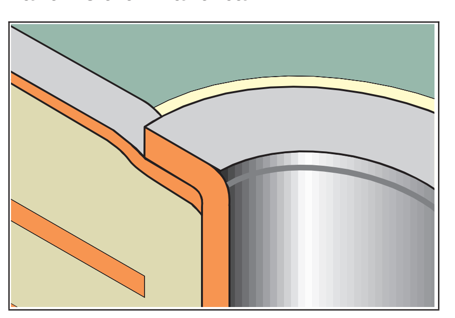


Figure 2 The eyelet flange can be used to secure a new conductor in place.



Figure 3 Set the eyelet using an eyelet press.

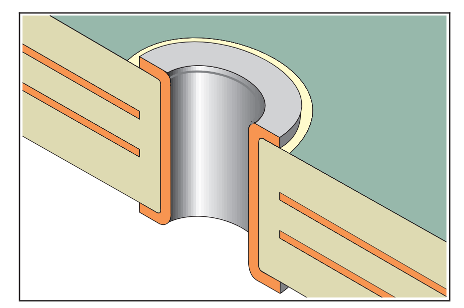


Figure 4 Completed repair.

FD Flange Diameter
The eyelet flange diameter should be small enough to prevent interference with adjacent pads or conductors.

OD Outside Diameter
The clearance hole should allow the eyelet to be inserted without force but should not exceed 0.125 mm greater than the eyelet outside diameter.

NOTE

Be sure to select an eyelet meeting the proper criteria. An eyelet with an oversize flange may interfere with adjacent conductors. An eyelet that is too short will not protrude through the printed wiring board for proper setting.

PROCEDURE

1. Clean the area.
2. Select an eyelet using the Eyelet Selection Criteria. Use a pin gauge and caliper to measure the existing plated hole dimensions.
3. Insert the appropriate ball mill into the hand held drill. Drill out the hole removing all the plating. The drilled hole should be 0.025 - 0.125 mm larger than the eyelet O.D. (See Figure 1.)

   CAUTION
   This procedure may isolate internal connections on multilayer printed wiring boards.
4. Clean the area.
5. Apply a small amount of liquid flux to the pad or conductor on the printed wiring board surface, if any, and tin with solder using a soldering iron and solder. Clean the area.
6. Insert the eyelet into the hole. If a new conductor is required, the new conductor may extend into the drilled hole and the flange of the eyelet will secure the new conductor in place. (See Figure 2.) The eyelet may be inserted from either side.
7. Select the proper setting tools and insert them into an eyelet press system. (See Figure 3.)
8. Turn the printed wiring board over and rest the eyelet flange on the lower setting tool.
9. Apply firm even pressure to form the eyelet barrel.

   NOTE
   Inspect the eyelet flange for evidence of damage. Refer to IPC-A-610 Acceptability of Electronic Assemblies.
10. Apply a small amount of liquid flux and solder the eyelet flanges to the pads on the printed wiring board surface if necessary. Clean the area. Inspect for good solder flow and wetting around the eyelet flanges and lands.

EVALUATION

1. Visual examination, dimensional requirement of pad diameter and inside diameter.
2. Electrical continuity measurement.

NOTES



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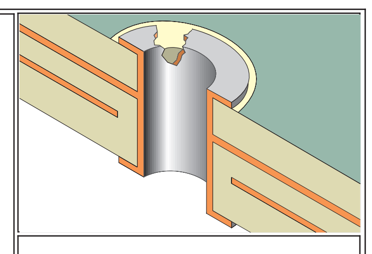
Repair and Modification of Printed Boards and Electronic Assemblies

Revision:

Date: 2/98

Number: 5.2

Plated Hole Repair, Double Wall Method



Product Class: R, F, W

Skill Level: Advanced

Level of Conformance: Medium

OUTLINE

This procedure covers the use of an eyelet for the repair of a damaged pad on a hole that has an inner layer connect.

CAUTION

This procedure is used to restore the integrity of a through connection on a multi-layer PC board, having an inner layer connect, but **ONLY** if the full barrel of the plated through hole remains intact. If there is barrel damage see appropriate procedure.

CAUTION

This method will reduce the inside diameter of the hole. The minimum hole size requirement must be checked for acceptance.

REFERENCES

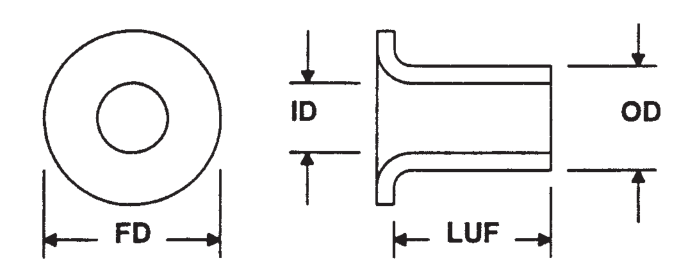
2.1 Handling Electronic Assemblies

2.2 Cleaning

TOOLS & MATERIALS

Ball Mills, Carbide	Liquid Flux
Buffer	Knife
Caliper	Microscope
Eyelets	Pin Gauges
Eyelet Press System	Solder
Eyelet Repair Kit	Solder Iron
Eyelet Setting Tools	Wipes
Hand Held Drill	

EYELET SELECTION CRITERIA



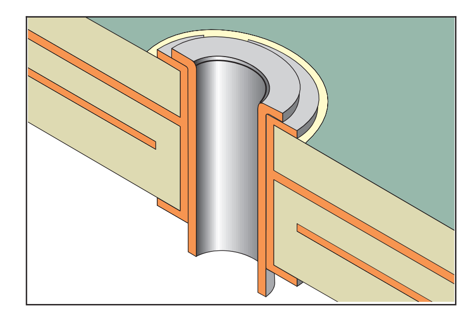


Figure 1 Insert the eyelet into the hole.



Figure 2 Set the eyelet using an eyelet press.

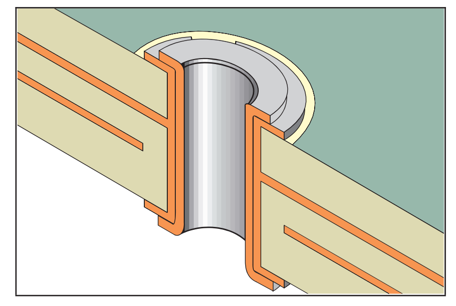


Figure 3 Completed repair.

ID Inside Diameter
The eyelet inside diameter should be a 0.075 - 0.500 mm greater than the component lead diameter.

LUF Length Under Flange
The length of the eyelet barrel under the flange should be 0.630 - 0.890 mm greater than the thickness of the PC board. This added length allows for proper protrusion when setting the eyelet.

FD Flange Diameter
The eyelet flange diameter should be small enough to prevent interference with adjacent pads or circuits.

OD Outside Diameter
The clearance hole should allow the eyelet to be inserted without force but should not exceed 0.125 mm greater than the eyelet outside diameter.

NOTE

Be sure to select an eyelet meeting the proper criteria. An eyelet with an oversize flange may interfere with adjacent circuits. An eyelet that is too short will not protrude through the PC board for proper setting.

PROCEDURE

1. Clean the area.
2. Examine the hole to ensure that there is no damage to the wall of the hole. Check continuity to establish the integrity of the connection.
3. Select an eyelet using the Eyelet Selection Criteria. Use a pin gauge and caliper to measure the existing plated hole dimensions. The eyelet must have an inside diameter sufficient to receive the component lead and an outside diameter that will allow the eyelet to be inserted into the hole without force.
4. Remove oxides from the surface pads where the eyelet is to be installed using a buffer and clean.
5. Apply a small amount of liquid flux to the pad or circuit on the PC board surface, if any, and tin with solder using a soldering iron and solder. Clean the area.
6. Insert the eyelet into the hole. If a new circuit is required, the new circuit may extend into the hole and the flange of the eyelet will secure the new circuit in place. (See Figure 1.)
7. Select the proper setting tools and insert them into an eyelet press system. (See Figure 2.)
8. Turn the PC board over and rest the eyelet flange on the lower setting tool.
9. Apply firm even pressure to form the eyelet barrel.
10. Apply a small amount of liquid flux and solder the eyelet flanges to the pads on the PC board surface if necessary. Clean the area. Inspect for good solder flow and wetting around the eyelet flanges and lands.
11. Clean the area.
12. Install the component lead and solder, if required.

EVALUATION

1. Visual examination, dimensional requirement of pad diameter and inside diameter.
2. Electrical continuity measurement.

NOTES



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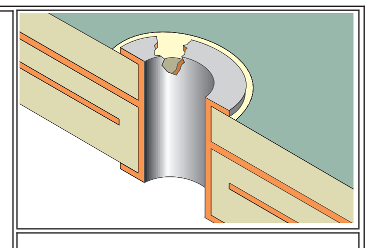
Repair and Modification of Printed Boards and Electronic Assemblies

Revision:

Date: 2/98

Number: **5.3**

Plated Hole Repair, Inner Layer Connection



Product Class: R

Skill Level: Expert

Level of Conformance: Medium

OUTLINE

This procedure describes the use of flat set eyelets for the repair of a through connection that has an inner layer connect, no surface wire is used. The inner layer reconnect is established by soldering the barrel of an eyelet to the exposed inner layer and the connection is encapsulated in high strength epoxy.

CAUTION

This is a complex repair procedure that demands the proper tools and materials. To expect reliable results, repair technicians must have a high level of expertise. Use this method only when alternative methods are unacceptable.

CAUTION

This procedure requires very accurate control over the location and depth of a milled hole. It is recommended that a precision drill system be used in combination with a high power stereo microscope.

REFERENCES

2.1 Handling Electronic Assemblies

2.2 Cleaning

TOOLS & MATERIALS

Ball Mills, Carbide	Hand Held Drill
Buffer	Liquid Flux
Caliper	Knife
Cleaner	Microscope
End Mills, Carbide	Pin Gauges
Eyelets	Precision Drill Press
Eyelet Press System	Solder
Eyelet Repair Kit	Solder Iron
Eyelet Setting Tools	Wipes

EYELET SELECTION CRITERIA

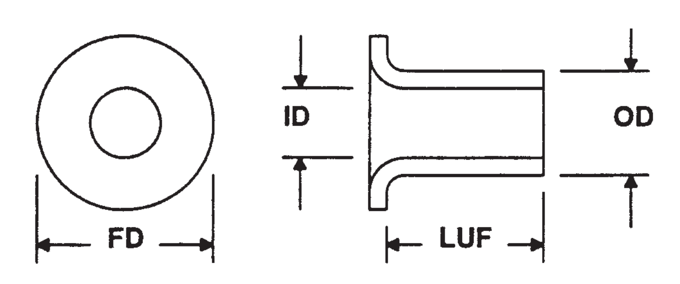




Figure 1 Drill press shown with PC board pinned in place.

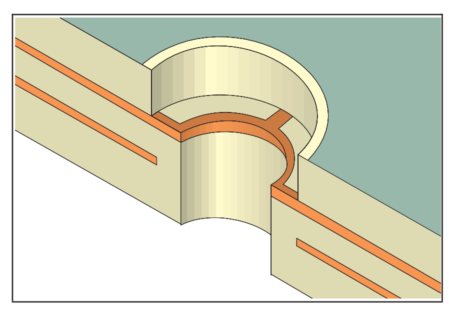


Figure 2 Mill down to and expose inner layer signal or plane.

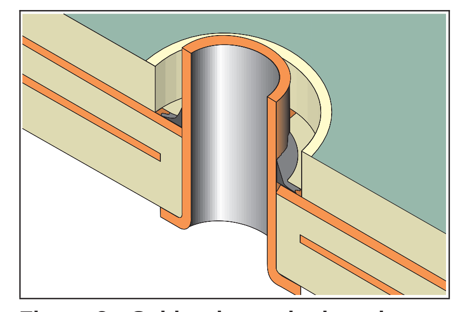


Figure 3 Solder the eyelet barrel to the exposed inner layer.

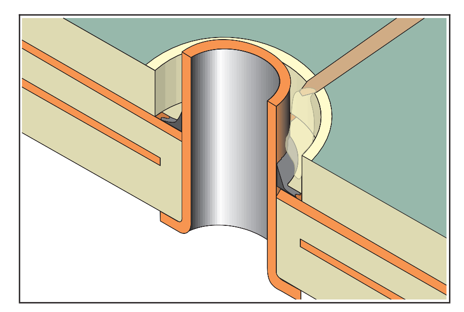


Figure 4 Fill the milled hole with the epoxy.

ID Inside Diameter
The eyelet inside diameter should be a 0.075 - 0.500 mm greater than the component lead diameter.

LUF Length Under Flange
The length of the eyelet barrel under the flange should be 0.630 - 0.890 mm greater than the thickness of the printed wiring board. This added length allows for proper protrusion when setting the eyelet.

FD Flange Diameter
The eyelet flange diameter should be small enough to prevent interference with adjacent pads or conductors.

OD Outside Diameter
The clearance hole drilled through the printed wiring board should allow the eyelet to be inserted without force but should not exceed 0.125 mm greater than the eyelet outside diameter.

NOTE

Be sure to select an eyelet meeting the proper criteria. An eyelet with an oversize flange may interfere with adjacent conductors. An eyelet that is too short will not protrude through the printed wiring board for proper setting.

PROCEDURE

1. Clean the area.
2. Select an eyelet using the Eyelet Selection Criteria. Use a pin gauge and caliper to measure the existing plated hole dimensions.
3. Pin the printed wiring board to the base of a precision drill press. (See Figure 1.)
4. Insert the appropriate ball mill, end mill or drill into the chuck of the drill press.
5. Mill or drill out the hole. The drilled hole should be approximately 0.030 mm larger than the eyelet O.D. Inspect to ensure no metallic particles or burrs remain.
6. Select the side of the assembly that will have a counterbored hole milled into it. This side preferably would have no surface connection.
7. Select an end mill approximately 0.050 - 0.075 mm larger than the eyelet diameter. Insert into the precision drill press and mill down to and expose the inner layer signal or plane. (See Figure 2.)

   CAUTION
   Great care must be taken to control the depth of the milled hole to prevent damage to the inner layer signal or plane.
8. Clean the area.
9. Apply a small amount of flux to the exposed signal or plane and tin with solder.
10. Clean the area.
11. Insert the eyelet into the hole from the side opposite the milled hole, then apply a small amount of flux into the milled hole.



Figure 5 Set the eyelet using an eyelet press.

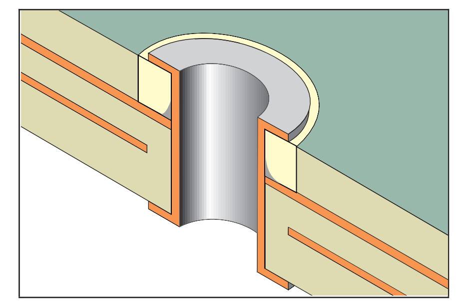


Figure 6 Eyelet barrel formed flat to PC board surface.

12. Solder the eyelet to the exposed inner layer signal or plane by applying heat from a soldering iron to barrel of the eyelet. (See Figure 3.)
13. Completely remove any solder flux residue by spray rinsing with cleaner.
14. Use a microscope and inspect the solder fillet from the eyelet to the inner connection and perform electrical tests as required.
15. Mix epoxy as required.
16. Fill the milled hole with the epoxy up to, and level with, the surface of the board. (See Figure 4.) The epoxy filler material should be free of voids and air bubbles.
17. Cure epoxy per the manufacturer's recommendations
18. Select the proper setting tools and insert them into the eyelet press. (See Figure 5.)
19. Turn the printed wiring board over and rest the eyelet flange on the lower setting tool.
20. Apply firm even pressure to form the eyelet barrel. (See Figure 6.)
21. Install the component lead and solder, if required.
22. Clean the area.

EVALUATION

1. Visual examination, dimensional requirement of pad diameter and inside diameter.
2. Electrical continuity measurement.

NOTES



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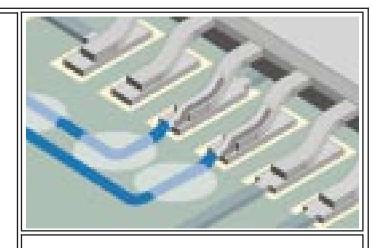
Repair and
Modification of
Printed Boards and
Electronic Assemblies

Revision:

Date: **11/99**

Number: **6.1**

Jumper Wires



Product Class: R/F/W/C
Skill Level: Intermediate
Level of Conformance: N/A

OUTLINE

This procedure covers the repair/modification of printed boards and electronic assemblies by the use of jumper wires to complete electrical continuity between two points. This procedure is meant to provide a foundation for adding jumper wires during the repair/modification process. The techniques and guidelines are based on general commercial and industry practices.

Jumper wires fall into three (3) categories

1. Those that are considered wires and are installed during assembly. The routing, termination, and bonding of these jumper wires are documented by engineering instructions or drawing notations.
2. Those that are added after assembly to effect a change or modification. The routing, termination, and bonding of these jumper wires are documented by engineering change notice instructions or drawing notations.
3. Those that are added to correct a defect.

This procedure has nine main sections.

1. References
2. Tools and Materials
3. General Rules
4. PC Board Preparation
5. Jumper Wire Selection
6. Jumper Wire Preparation
7. Jumper Wire Termination and Routing
8. Jumper Wire Bonding
9. Jumper Wire Termination Figures

REFERENCES

1.0 Foreword
2.1 Handling Electronic Assemblies
2.2 Cleaning
2.5 Baking and Preheating

TOOLS & MATERIALS

Adhesive, Hot Melt
Adhesive, Quick Set
Cleaner
Cleaning Wipes
Flush Cutter
Flux, Liquid
Smooth Pliers
Solder
Soldering Iron with Tips
Tape Dots
Wire
Wire, Adhesive Coated
Wire Stripper

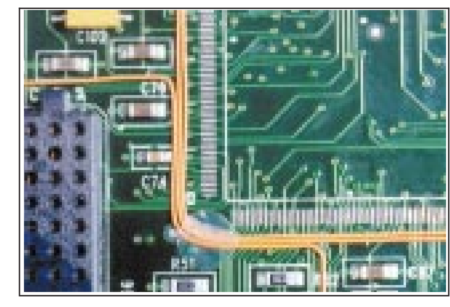


Figure 1 Route jumper wires.

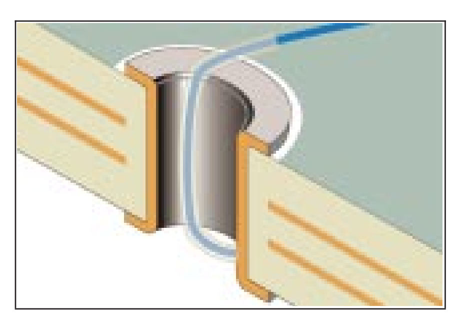


Figure 2 Use sleeving through PTH.

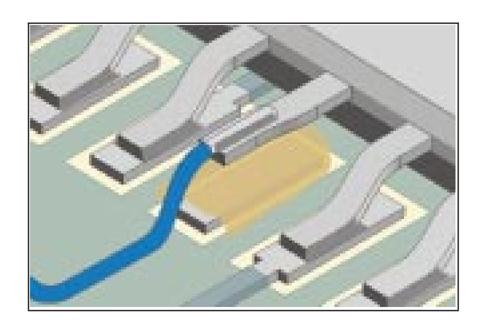


Figure 3 Use insulated wire if required.

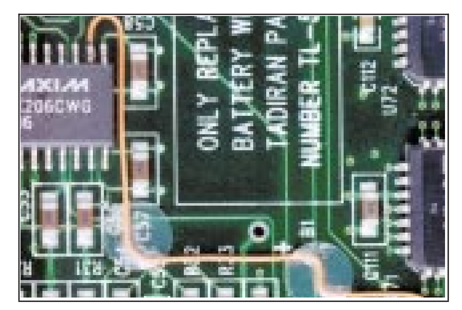


Figure 4 Bond wires using tape dots or strips.

GENERAL RULES

1. Jumper wires should be placed on the component side of the assembly or printed board unless otherwise specified.
2. Jumper wires shall be routed in an XY manner as directly as feasible, making as few bends as possible. (See Figure 1.)
3. Jumper wires shall not be raised more than 3.2 mm [0.125 in] above the board surface or not above components or leads in such a way that they will interfere with PC board mounting.
4. Bare conductor jumper wires longer than 12.7 mm [0.50 in] shall not be used. Bare conductor jumper wires shorter than 12.7 mm [0.50 in] shall not violate the minimum electrical clearance.

   NOTE
   The 12.7 mm [0.50 in] dimension refers to the length between terminations.
5. Jumper wires may pass over lands provided sufficient slack is available so that the wire can be moved away from the land for component replacement. Jumper wires shall not pass over pads or vias used as test points.
6. Jumper wires shall not be routed under or over component leads or component bodies. Contact with heat sinks must be avoided.
7. Jumper wires shall not pass through component foot prints unless the layout of the assembly prohibits the routing in other areas.
8. Jumper wires shall have stress relief.
9. Jumper wires may be routed through plated through holes provided the wire is insulated and insulation sleeving is placed in the hole. If a hole is needed, use the following method. (See Figure 2.)
   A. Drill a hole 0.25 mm [0.010 in] larger than the insulation diameter.
   B. Inspect the hole for burs or exposed internal circuits.
   C. Document the added hole on a control drawing.

   NOTE
   Be careful that the drilled hole does not interfere with surface and internal conductors.
10. Jumper wires soldered into plated through holes must be discernible on the opposite side.
11. Jumper wires soldered to lifted or clipped component leads may require insulation to prevent shorting. (See Figure 3.)
12. Jumper wires may be terminated by a variety of methods. See illustrations.

PC BOARD PREPARATION

1. Clean the area.

   NOTE
   When wires are in place cleaning will often be more difficult.
2. Remove coating material or oxidization as necessary from the component leads, pads, or conductors where wire terminations will be soldered. Clean the area.

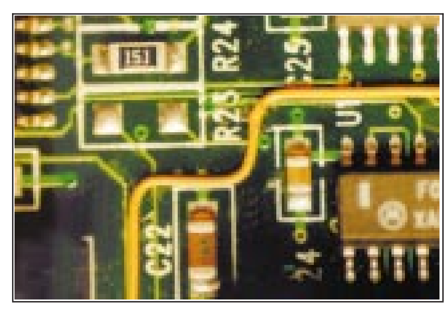
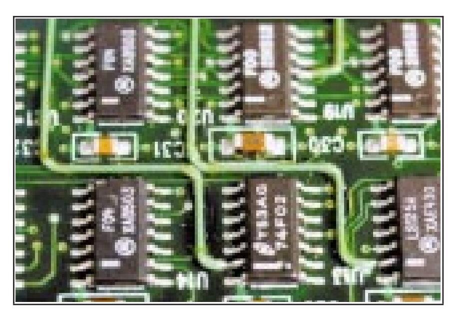


Figure 5 Bond wires using adhesive.


Figure 6 Adhesive coated wires are heat bonded.

3. Remove solder from the connection point if needed. Clean the area.
4. Measure approximately the length of each wire needed.

JUMPER WIRE SELECTION

1. Bare conductor jumper wires longer than 12.7 mm [0.50 in] shall not be used. Bare conductor jumper wires shorter than 12.7 mm [0.50 in] shall not violate the minimum electrical clearance.

   NOTE
   The 12.7 mm [0.50 in] dimension refers to the length between terminations.
2. Silver plated wire must not be used; under some conditions corrosion of the wire can occur.
3. The smallest diameter wire that will carry the required current should be selected.
4. Insulation requirements of the wire should withstand soldering temperatures, have some resistance to abrasion, have a dielectric resistance equal to or better than the board insulation material.
5. Recommended wire is solid insulated copper wire, tin lead plated, 22 to 32 AWG with Kynar, Milene, Kapton, Teflon or equivalent insulation.

   CAUTION
   Wires with nicked or damaged conductors should not be used.

JUMPER WIRE PREPARATION

1. Cut the jumper wires approximately 12.7 mm [0.50 in] longer than the estimated length needed.

   NOTE
   The length and gauge of the jumper wire may be critical. All wires have an electrical resistance (impedance) to the flow of electricity. This impedance is important to electronic circuitry. Always refer to wiring lists for specific jumper wire requirements.
2. Strip insulation from each end of the jumper wire.

   NOTE
   Strip length is dependent on the termination style.
3. If required, tin the stripped ends with solder. Clean if necessary.

JUMPER WIRE TERMINATING AND ROUTING

1. Form the wire as needed and place the wire in position depending on the termination style. Center the wire on the component lead or pad, do not overhang sides. If the wire is soldered to a pin, terminal or component lead, wrap the wire a minimum of 90°.
2. Solder one end of the wire. Clean if necessary.

   NOTE
   Solder joint length must meet acceptability requirements.

CAUTION
The insulation shall not be stripped back more than two wire diameters from the solder joint. Wire insulation may touch but not penetrate the solder joint provided proper wetting of the wire is evident.

3. Bend the wire as needed and run the wire along board surface. Route the jumper wire using the shortest route in an XY direction with the fewest possible bends to the second termination point.

NOTE
Jumper wires shall not be routed under or over component leads or component bodies. Contact with heat sinks must be avoided.

CAUTION
Do not bend the wire tighter than a radius of three times the conductor diameter.

4. After routing the jumper wire, solder the opposite end. Clean if necessary.

CAUTION
Wires soldered to lifted or clipped components leads may require insulation to prevent shorting.

JUMPER WIRE BONDING

1. After the wire has been soldered at both ends and cleaned if necessary, the wire should be bonded to the board surface.

NOTE
Bonding is not required if wire is insulated and insulated length is less than 25 mm [1.00 in].

2. Bond the jumper wire using one of the following methods.
   A. Tape Dots or Tape Strips. (See Figure 4.)
   B. Quick Set Adhesive. (See Figure 5.)
   C. Hot Melt Adhesive. (See Figure 5.)
   D. Hot Bonding. Some jumper wires are manufactured with a special thermo-set adhesive coating and are thermally bonded to the board surface with a special bonding tool. (See Figure 6.)
3. Bond the jumper wire within 6.0 mm [0.25 in] of each solder joint.
4. Bond the jumper wire within 6.0 mm [0.25 in] of each bend in the wire.
5. Bond the jumper wire at intervals not less than 25 mm [1.00 in] on straight runs.

Table 1 Jumper Wire Termination Methods

Figure	Type	Wire Termination Method	Acceptability
7	PTH Hole	Wire soldered into plated-through hole on component side. *	Acceptable
8	PTH Lead	Wire soldered parallel to lead on component side.	Acceptable
9	PTH Hole	Wire soldered into plated-through hole on solder side. *	Acceptable
10	PTH Hole	Wire wrapped around component lead on solder side.	Acceptable
11	PTH Hole	Wire wrapped around lead on component side.	Acceptable
12	PTH Lead	Wire soldered to lifted component lead. +	Acceptable
13	PTH Lead	Wire soldered to clipped lead on component side. +	Acceptable
14	PTH Lead	Wire looped and soldered to adjacent component leads.	Acceptable
15	PTH Lead	Wire soldered to lead, wire over component.	Not Recommended
16	PTH Lead	Soldered perpendicular to component lead.	Not Recommended
17	PTH Lead	Multiple wires soldered to component lead overhanging edge.	Not Recommended
18	Chip	Wire soldered to pad, parallel or perpendicular to component.	Acceptable
19	Chip	Wire soldered parallel or perpendicular to component.	Acceptable
20	Chip	Wire soldered to component end, lifted off pad.	Acceptable
21	Chip	Multiple wires overhanging pad edge.	Not Recommended
22	PTH Hole	Wire soldered into plated-through hole. *	Acceptable
23	PTH Pad	Wire soldered across top of PTH pad.	Acceptable
24	PTH Pad	Multiple wires soldered to pad overhanging pad edge.	Not Recommended
25	Conductor	Wire soldered parallel to conductor, contact, SMT pad.	Acceptable
26	Conductor	Wire perpendicular to conductor, contact, SMT pad.	Not Recommended
27	Conductor	Multiple wires soldered to conductor, contact, SMT pad.	Not Recommended
28	J Lead	Wire soldered parallel to component lead.	Acceptable
29	J Lead	Wire soldered to clipped component lead. +	Acceptable
30	J Lead	Wire looped and soldered to adjacent component leads.	Acceptable
31	J Lead	Wire soldered to component lead, wire running over component.	Not Recommended
32	J Lead	Wire soldered perpendicular to lead.	Not Recommended
33	J Lead	Multiple wires soldered to lead overhanging edge.	Not Recommended
34	J Lead	Wire soldered to lifted component lead.	Not Recommended
35	Gull Wing	Wire soldered parallel to component lead.	Acceptable
36	Gull Wing	Wire soldered to lifted component lead. +	Acceptable
37	Gull Wing	Wire soldered to clipped component lead. +	Acceptable
38	Gull Wing	Wire looped and soldered to adjacent component leads.	Acceptable
39	Gull Wing	Wire soldered to component lead, wire over component.	Not Recommended
40	Gull Wing	Wire soldered perpendicular to component lead.	Not Recommended
41	Gull Wing	Multiple wires soldered to lead overhanging edge.	Not Recommended

* Jumper wires soldered into plated-through holes must be discernible on the opposite side.
+ Jumper wires soldered to lifted or clipped component leads may require insulation to prevent shorting.

Jumper Wire Termination Figures – Through-Hole Components

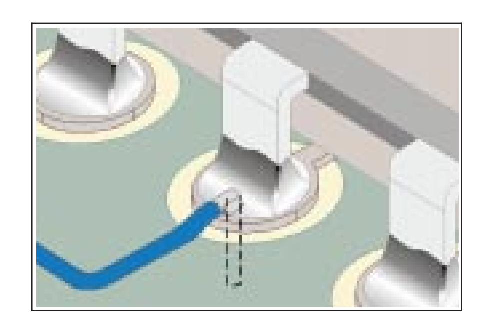


Figure 7 ***Acceptable*** Wire soldered into plated-through hole, component side. *

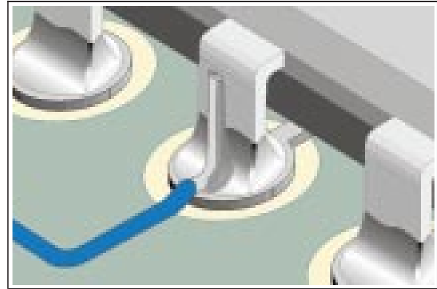


Figure 8 ***Acceptable*** Wire soldered parallel to lead on component side.

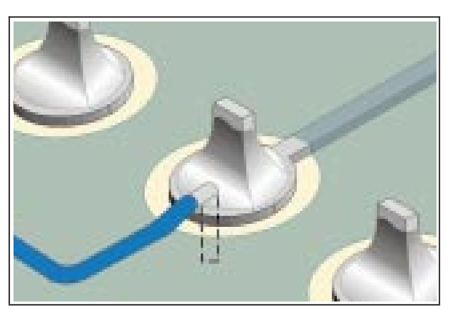


Figure 9 ***Acceptable*** Wire soldered into plated-through hole on solder side. *

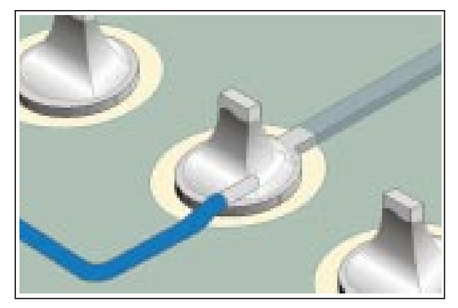


Figure 10 ***Acceptable*** Wire wrapped around component lead on solder side.

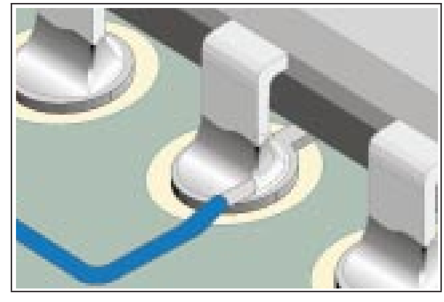


Figure 11 ***Acceptable*** Wire wrapped around lead on component side.

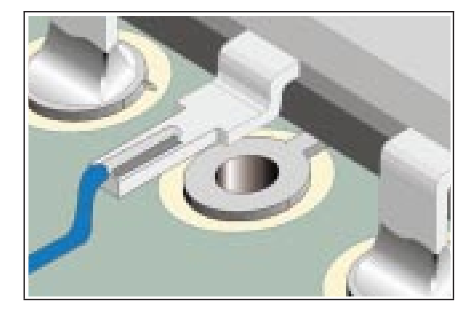


Figure 12 ***Acceptable*** Wire soldered to lifted component lead. +

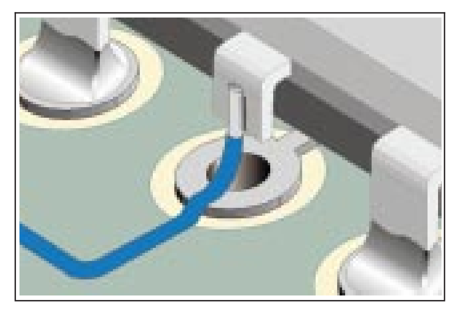


Figure 13 ***Acceptable*** Wire soldered to clipped lead on component side. +

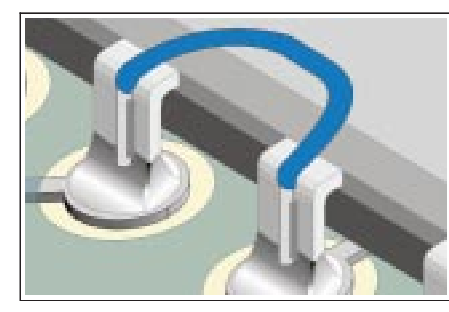


Figure 14 ***Acceptable*** Wire looped and soldered to adjacent component leads.



Figure 15 ***Not Recommended*** Wire soldered to lead, wire over component.

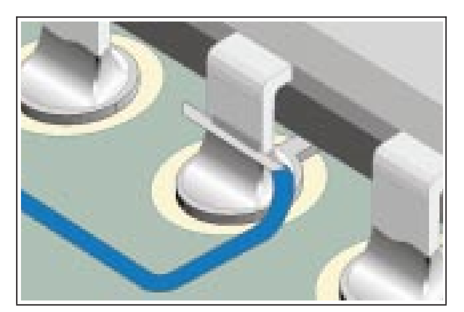


Figure 16 ***Not Recommended*** Soldered perpendicular to component lead.

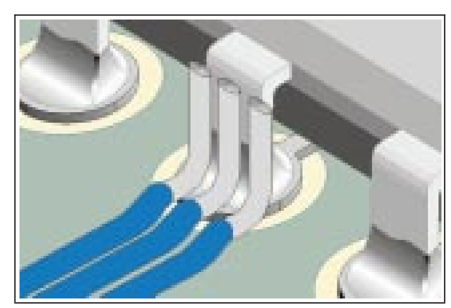


Figure 17 ***Not Recommended*** Multiple wires soldered to lead overhanging edge.

* Jumper wires soldered into plated-through holes must be discernible on the opposite side.

+ Jumper wires soldered to lifted or clipped component leads may require insulation to prevent shorting.

Jumper Wire Termination Figures – Chip Components, Pads and Conductors

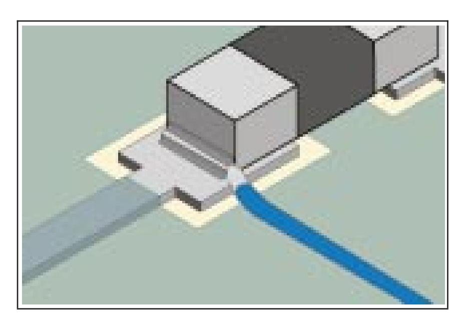


Figure 18 ***Acceptable*** Wire soldered to pad, parallel or perpendicular to component.

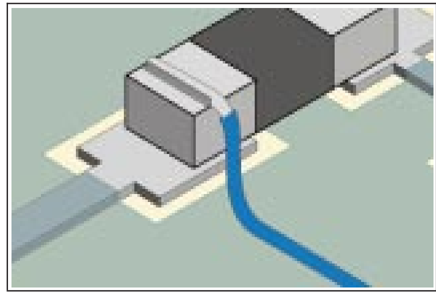


Figure 19 ***Acceptable*** Wire soldered parallel or perpendicular to component.

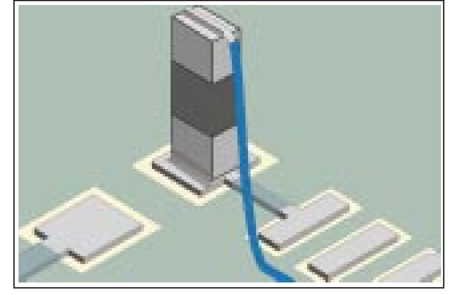


Figure 20 ***Acceptable*** Wire soldered to component end, lifted off pad.

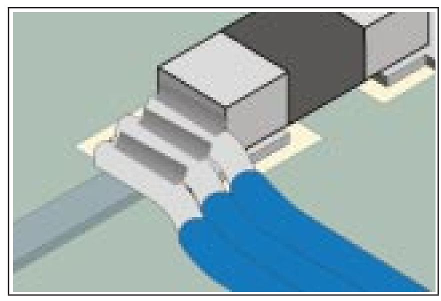


Figure 21 ***Not Recommmended*** Multiple wires overhanging pad edge.

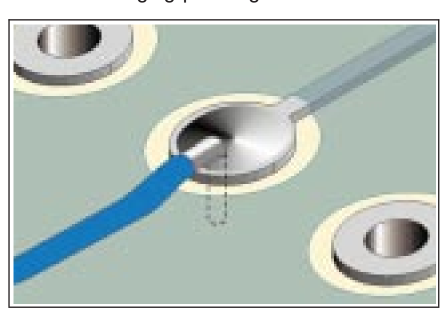


Figure 22 ***Acceptable*** Wire soldered into plated-through hole. *

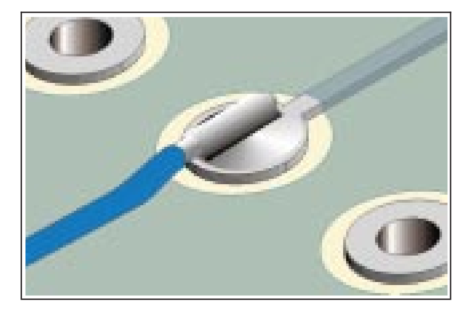


Figure 23 ***Acceptable*** Wire soldered across top of PTH pad.

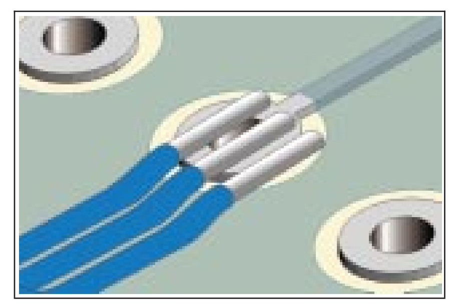


Figure 24 ***Not Recommended*** Multiple wires soldered to pad overhanging pad edge.

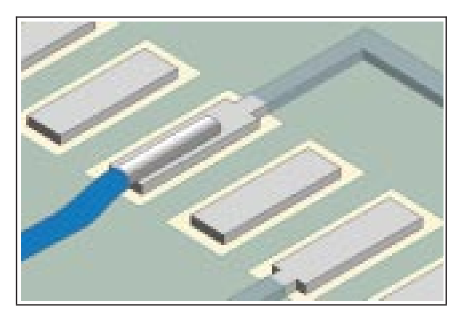


Figure 25 ***Acceptable*** Wire soldered parallel to conductor, contact, SMT pad.

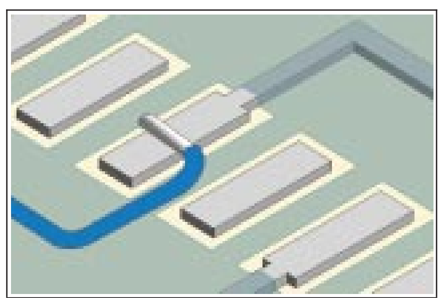


Figure 26 ***Not Recommended*** Wire perpendicular to conductor; contact, SMT pad.

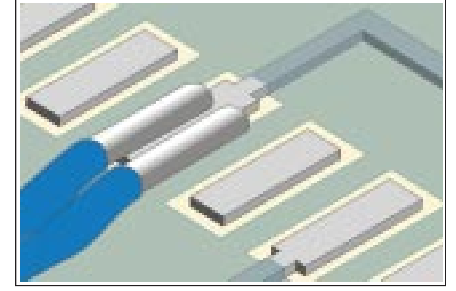


Figure 27 ***Not Recommended*** Multiple wires soldered to conductor, contact, SMT pad.

* Jumper wires soldered into plated-through holes must be discernible on the opposite side.
+ Jumper wires soldered to lifted or clipped component leads may require insulation to prevent shorting.

Jumper Wire Termination Figures – J Lead Components

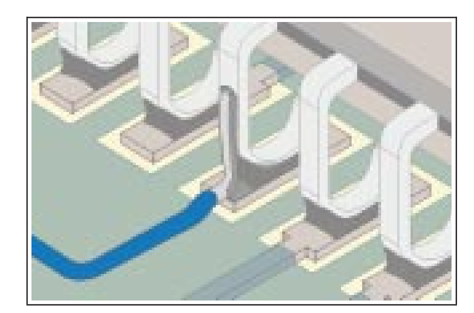


Figure 28 ***Acceptable*** Wire soldered parallel to component lead.

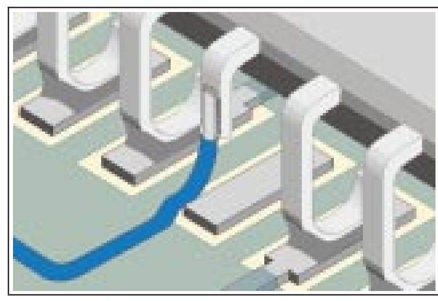


Figure 29 ***Acceptable*** Wire soldered to clipped component lead. +

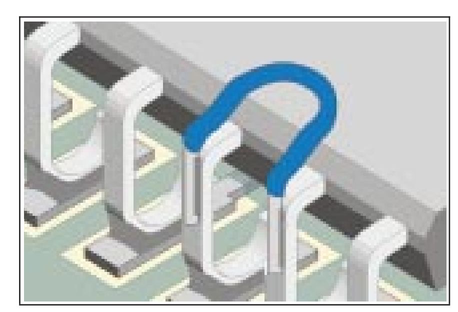


Figure 30 ***Acceptable*** Wire looped and soldered to adjacent leads.

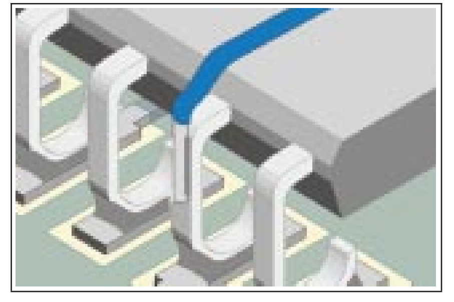


Figure 31 ***Not Recommended*** Wire soldered to lead, over component.

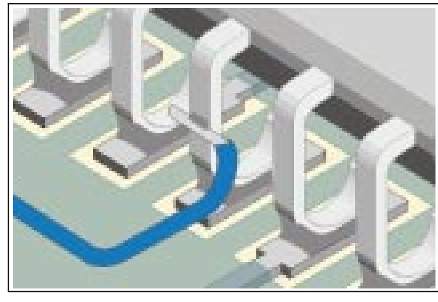


Figure 32 ***Not Recommended*** Wire soldered perpendicular to lead.

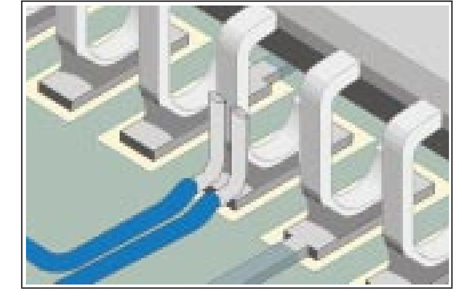


Figure 33 ***Not Recommended*** Multiple wires soldered to lead overhanging edge.

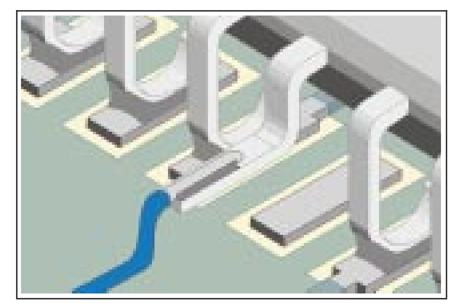


Figure 34 ***Not Recommended*** Wire soldered to lifted component lead.

* Jumper wires soldered into plated-through holes must be discernible on the opposite side.

+ Jumper wires soldered to lifted or clipped component leads may require insulation to prevent shorting.

Jumper Wire Termination Figures – Gull Wing Components

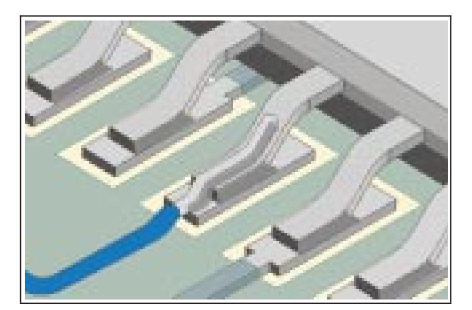


Figure 35 ***Acceptable*** Wire soldered parallel to component lead.

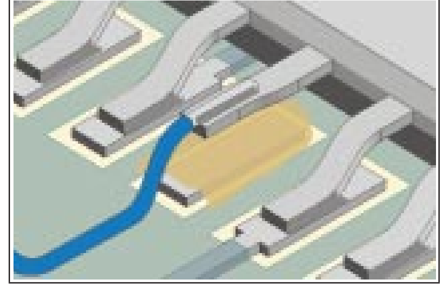


Figure 36 ***Acceptable*** Wire soldered to lifted component lead. +

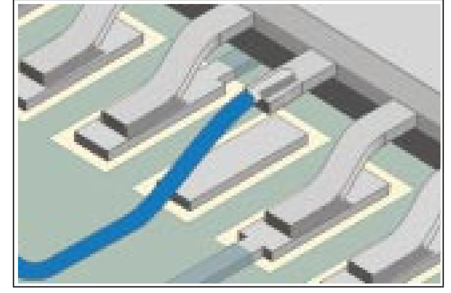


Figure 37 ***Acceptable*** Wire soldered to clipped component lead. +

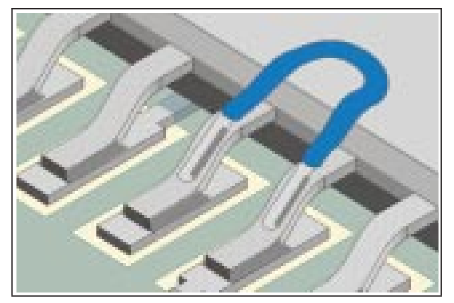


Figure 38 ***Acceptable*** Wire looped and soldered to adjacent component leads.

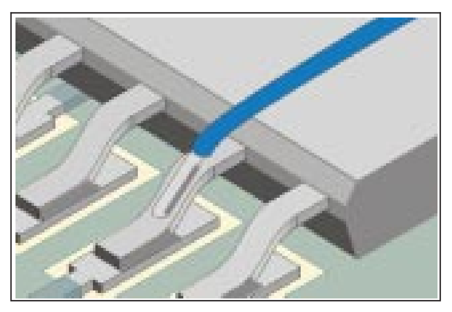


Figure 39 ***Not Recommended*** Wire soldered to component lead, wire over component.

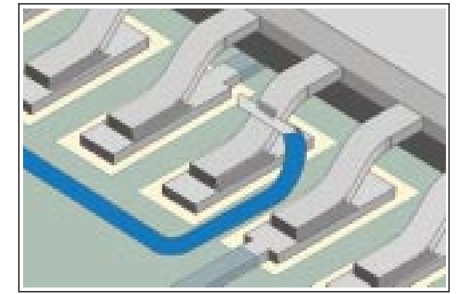


Figure 40 ***Not Recommended*** Wire soldered perpendicular to component lead.

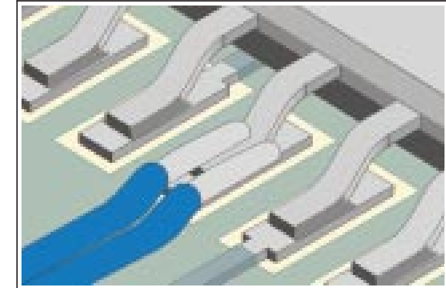


Figure 41 ***Not Recommended*** Multiple wires soldered to lead overhanging edge.

* Jumper wires soldered into plated-through holes must be discernible on the opposite side.
+ Jumper wires soldered to lifted or clipped component leads may require insulation to prevent shorting.

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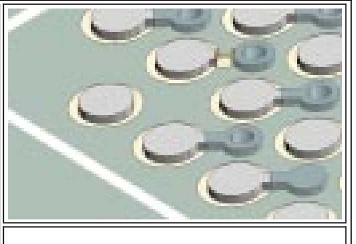
Repair and Modification of Printed Boards and Electronic Assemblies

Revision:

Date: **11/99**

Number: **6.2.1**

Jumper Wires, BGA Components, Foil Jumper Method



Product Class: R/F

Skill Level: Expert

Level of Conformance: Medium

OUTLINE

This method is used to change a circuit path at a BGA site for engineering changes or modifications.

NOTE

This procedure requires precision milling equipment and highly trained technicians.

CAUTION

This procedure is not applicable for ‘‘via in pad’’ applications.

REFERENCES

1.0 Foreword
2.1 Handling Electronic Assemblies
2.2 Cleaning
2.5 Baking And Preheating
2.6 Epoxy Mixing and Handling
4.2.1 Conductor Repair, Foil Jumper, Epoxy Method
4.4.3 Surface Mount, BGA Pad Repair, Film Adhesive Method
6.1 Jumper Wires

TOOLS & MATERIALS

BGA Rework System
Bonding Iron
Bonding Tips
Bonding System
Buffer
Circuit Frames, BGA Pads
Cleaner
Drill System
End Mills
Epoxy
Flux, Liquid
Foil Jumpers
Heat Lamp
Microscope
Milling System
Oven
Precision Knife
Repair System or Repair Kit
Scraper
Solder
Soldering Iron
Tape, High Temperature
Tweezers
Wipes

PROCEDURE

1. Clean the area.
2. Remove the BGA component if installed, remove excess solder from the pads, and clean and inspect the site using standard BGA rework equipment.
3. Cut the short conductor (dog bone) connecting the BGA pad to the connecting via using a drill system or milling machine and appropriate size end mill. (See Figure 1 and 6.)
4. Remove the existing BGA pad. Apply heat from a soldering iron if needed. (See Figure 2.)

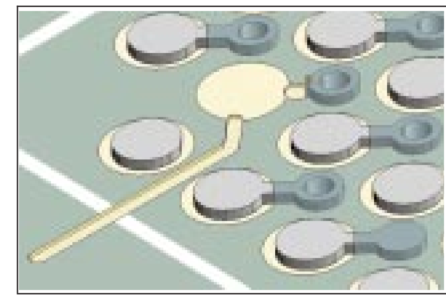


Figure 1 Cut the connection to the via using a drill system.

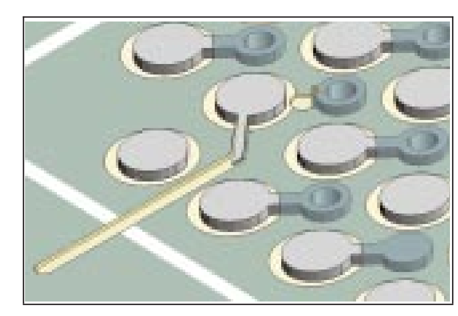


Figure 2 Remove BGA pad & mill shallow channel into solder mask surface.

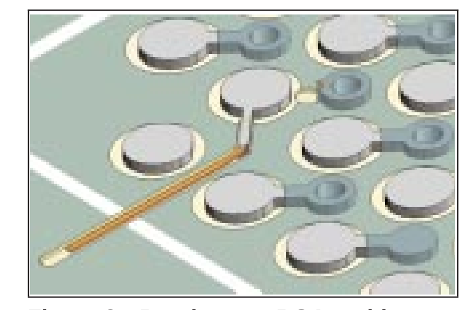


Figure 3 Bond a new BGA pad in place.

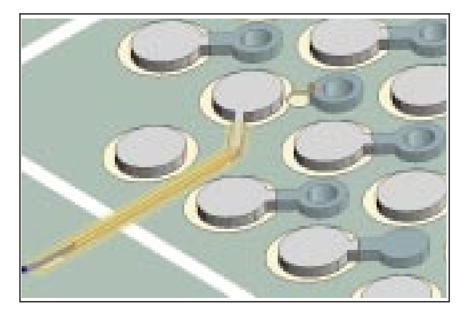


Figure 4 Solder a foil jumper to the tail extending from the new BGA pad.

5. Inspect the proposed path for the foil jumper to ensure proper clearance. Use a milling machine to mill a shallow groove in the solder mask surface from the BGA pad area to the perimeter of the BGA site. Tight spacing may restrict the width of the channel to 0.25 mm [0.010 in] or less. Use a carbide end mill approximately 0.050 mm [0.002 in] wider than the new connecting circuit. (See Figure 3.)

   NOTE
   Be sure to mill a shallow groove to prevent damage to internal conductive layers.

6. Bond a replacement BGA pad in place using a bonding system. (See Procedure 4.7.3.) The new BGA pad must have a tail that will align with the foil jumper to be added next. (See Figure 4.)
7. Select a foil jumper to match the width and thickness of the circuit to be replaced. Cut a length approximately as needed. The foil jumper should overlap the BGA tail section a minimum of two times the circuit width.
8. Gently abrade the top and bottom ends of the new foil jumper with the buffer to remove any oxidation and clean.

   NOTE
   If needed, the ends of the foil jumper may be tinned with solder prior to lap soldering in place.

9. Position this new foil jumper along the milled groove. The foil jumper should overlap the existing circuit a minimum of two times the circuit width. (See Figure 4.)
10. Apply a small amount of liquid flux to the overlap joint.
11. Lap solder the foil jumper to the BGA tail section using solder and a soldering iron. Make sure the foil jumper is properly aligned.
12. Clean the area.
13. Mix epoxy. If desired, add color agent to the mixed epoxy to match the printed wiring board color.
14. Coat the top and bottom of the foil jumper with epoxy. The epoxy bonds the new circuit to the base board material and insulates the circuit. (See Figure 5.)

   CAUTION
   Some components may be sensitive to high temperature.

16. Clean the board as required.
17. Install new BGA per applicable procedures.
18. Solder one end of a fine gauge wire to the end of the extending foil jumper. (The opposite end of the wire will be soldered later.) (See Figure 5.)
19. Route and terminate the other end of the jumper wire.

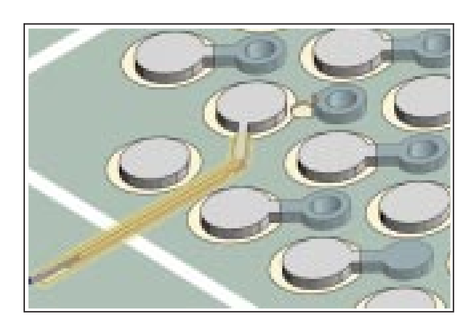


Figure 5 Solder a wire to the foil jumper bond with epoxy.



Figure 6 Sample of drill system used to cut the connection from the BGA pad to the via.

EVALUATION

1. Visual examination for alignment and overlap of new circuit.
2. Visual examination of epoxy coating for texture and color match.
3. Electrical tests as applicable.



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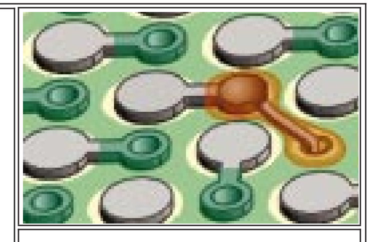
Repair and Modification of Printed Boards and Electronic Assemblies

Revision:

Date: **10/03**

Number: **6.2.2**

Jumper Wires, BGA Components, Through Board Method



Product Class: R/F
Skill Level: Expert
Level of Conformance: High

OUTLINE

This method is used to add a foil jumper at a BGA site by running the foil jumper through a hole in the board. This method is normally used for engineering changes or modifications.

NOTE

This procedure requires precision milling equipment and highly trained technicians. This method is used when there is a buried via, and other methods of terminating to the opposite side are not an option.

REFERENCES

1.0 Foreword
2.1 Handling Electronic Assemblies
2.2 Cleaning
2.5 Baking and Preheating
2.7 Epoxy Mixing and Handling
6.1 Jumper Wires

TOOLS & MATERIALS

BGA Rework System
Buffer
Cleaner
End Mills
Epoxy
Flux, Liquid Foil Jumper
Heat Lamp Microscope
Milling System
Oven
Precision Drill System
Precision Knife
Scraper
Solder
Soldering Iron
Tape, High Temperature
Teflon Sleeving
Tweezers
Wipes
Wire

PROCEDURE

1. Clean the area.
2. Remove the BGA component if installed, remove excess solder from the pads. Clean and inspect the site.
3. Remove solder mask from the via pad terminating to the subject BGA pad.
4. Mill a hole through the board at the precise coordinates using a Precision Drill System and End Mill of the appropriate size. (See Figure 1 and 5.)

   NOTE
   Although both power and ground planes may be cut, inner layer signal traces must be avoided.
5. Carefully inspect the milled hole and clean the area.

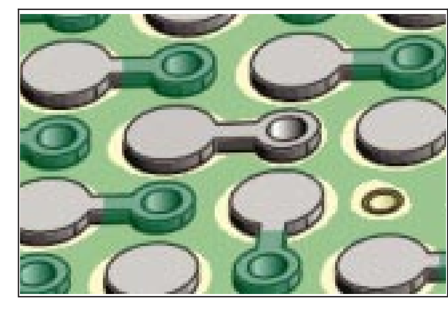


Figure 1 Mill a hole through the board and insert a Teflon sleeve.

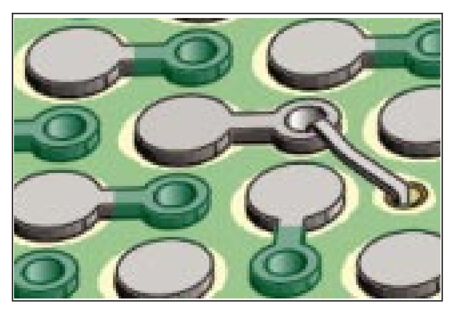


Figure 2 Insert a copper foil jumper into the plated hole and Teflon sleeve.

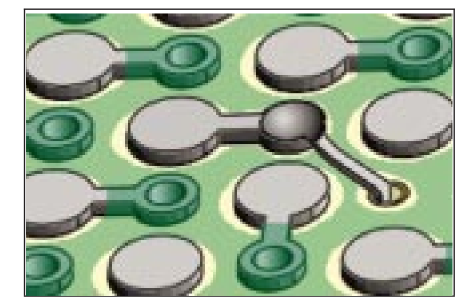


Figure 3 Solder the foil jumper to the plated hole connected to the BGA pad.

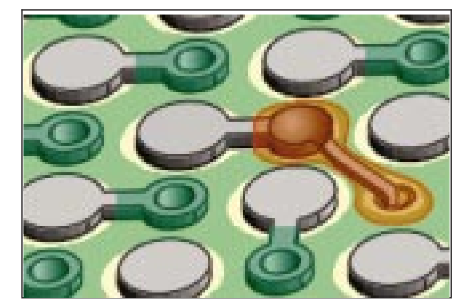


Figure 4 Overcoat the new connection with epoxy.

6. Select the appropriate size foil jumper. Cut a length approximately as needed. The overlap solder connection should be a minimum of two times the circuit width. (See Table 1.)

Table 1 Common Foil Jumper Sizes

Thickness	Width
0.002''	0.004''
0.002''	0.006''
0.002''	0.008''
0.002''	0.010''
0.003''	0.120''
0.003''	0.015''
0.005''	0.020''
0.005''	0.030''



Figure 5 Precision Drill System used for milling the Teflon sleeved hole.

7. Gently abrade the top and bottom of the foil jumper with the buffer to remove any oxidation and clean.

   NOTE

   If needed, the ends of the foil jumper may be tinned with solder prior to lap soldering in place.

8. Insert an appropriately sized Teflon sleeve into the milled hole. This sleeve will insulate foil jumper and prevent shorting to the inner layers. (See Figure 1.)
9. Insert one end of the foil jumper into the plated hole connected to the BGA pad. Insert the opposite end through the Teflon sleeve. (See Figure 2.)

   NOTE

   Observe care to keep the Teflon sleeve in position while inserting the foil jumper.

10. Apply a small amount of liquid flux and solder the foil jumper to the plated hole connected to the BGA pad using solder and a soldering iron. Make sure the foil jumper is properly aligned. (See Figure 3.)
11. Clean the area.
12. Mix epoxy per appropriate procedure.
13. Coat the top and sides of the foil jumper with epoxy. The epoxy bonds the foil jumper to the base board material and insulates it. (See Figure 4).

    NOTE

    Keep the epoxy height below the BGA pad level.

    CAUTION

    Some components may be sensitive to high temperature.

14. Clean the circuit board as required.
15. Install new BGA component per applicable procedures.
16. Solder a jumper wire to the exposed foil jumper on the opposite side of the circuit board. Route and terminate the jumper wire as needed.

EVALUATION

1. Visual examination for alignment and overlap of foil jumper.
2. Visual examination of epoxy coating for texture and color match.
3. Electrical tests as applicable.

NOTES



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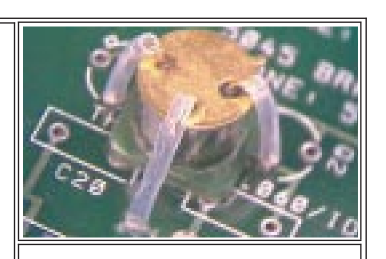
Repair and Modification of Printed Boards and Electronic Assemblies

Revision:

Number: **6.3**

Date: **03/01**

Component Modifications and Additions



Product Class: R,F,W,C
Skill Level: Advanced
Level of Conformance: N/A

OUTLINE

This procedure covers the general guidelines for modifications that involve adding components.

REFERENCES

1.0 Index
2.1 Handling Electronic Assemblies
2.2 Cleaning
2.5 Baking and Preheating

TOOLS & MATERIALS

Cleaner	Microscope System
Cleaning Wipes	Soldering Iron with Tips
Flux	Solder

GENERAL RULES

1. Added components may need to be secured with adhesive, or by other means, if the component leads or component body would be subjected to mechanical stress.
2. Leads of added components should not be inserted into plated holes occupied by another component lead.
3. Added components placed on the circuit board surface should be placed on the component side of the assembly or circuit board unless otherwise specified.
4. Added components shall not be raised above the board surface beyond allowable dimensions.
5. Added components shall not cover over pads or vias used as test points.
6. Added components shall not cover other component foot prints unless the layout of the assembly prohibits mounting in other areas.
7. Added component leads may require insulation to avoid contact with component body or other conductors.
8. Removal of existing solder from a connection point may be necessary to avoid bridging, or excess solder, in the final connection.
9. Consider design limitations and product use environments when stacking components.
10. Do not exceed minimum component lead bend radius.
11. When possible, component identification marking shall be legible.

PROCEDURE

1. When required, form the component leads and clean the area.
2. When required, secure the component in place by bending leads or other mechanical means.
3. Apply flux to the connection.
4. Place the soldering iron tip at the connection between both leads. Apply a small amount of solder at the connection of soldering iron tip and lead to form a solder bridge.
5. Immediately feed solder into the joint from the side opposite the soldering iron tip until the proper fillet is achieved. Remove the solder and iron simultaneously.
6. When required, clean the flux residue.
7. Inspect.

Component Modification Examples

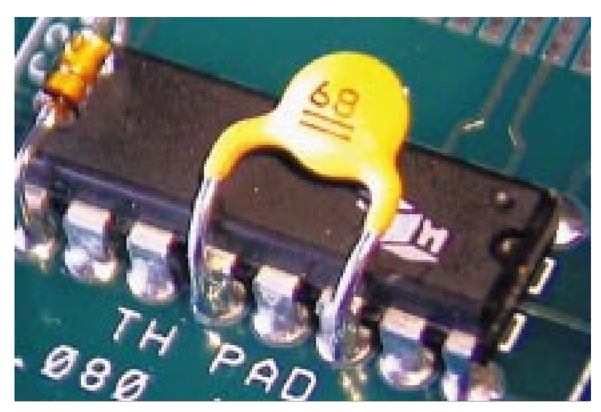


Figure 1 Radial lead component soldered to through hole component leads. Note: Leads of the radial component should not need to be inserted into the plated holes.

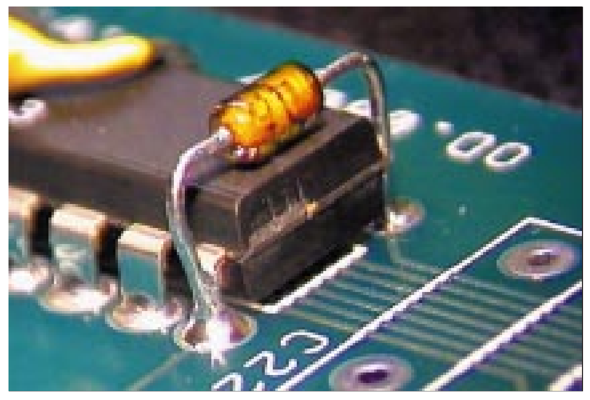


Figure 2 Axial lead component soldered to through hole component leads. Note: Leads of axial component should not be inserted into the plated holes.

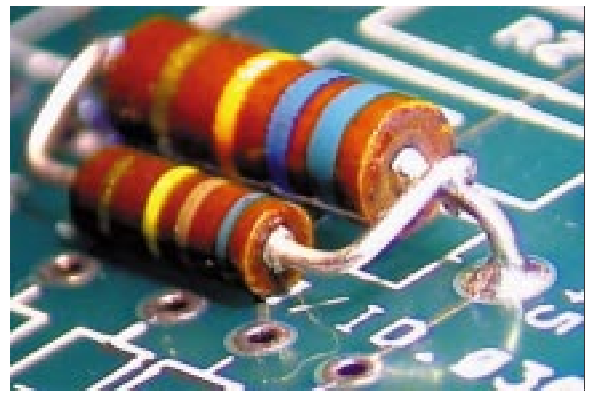


Figure 3 Axial lead component soldered to adjacent axial lead component. Note: Added component may be stacked vertically or horizontally.



Figure 4 Chip component soldered to surface mount component using jumper wires. Note: One lead of surface mount component is shown lifted.

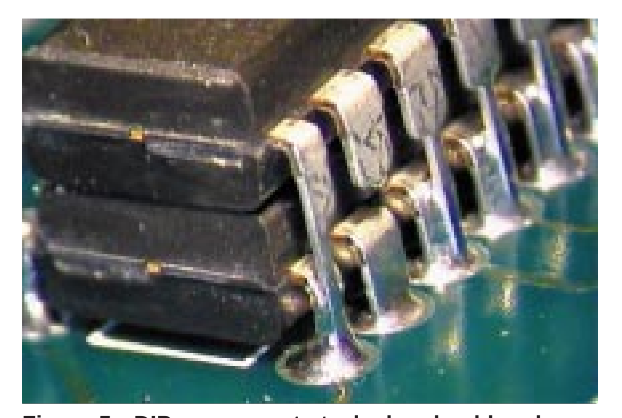


Figure 5 DIP component stacked and soldered onto another DIP component. One lead shown clipped. Note: Leads of added component should not be inserted into the plated holes.

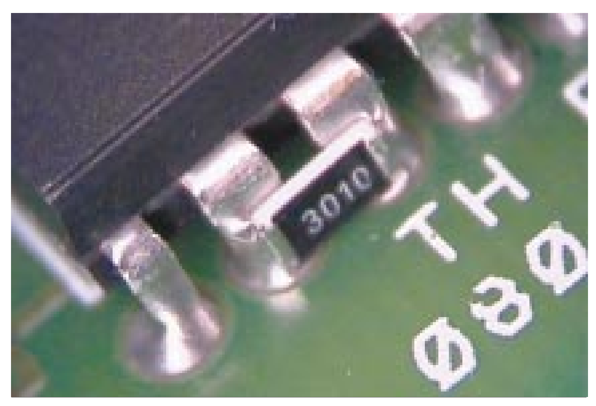


Figure 6 Chip cap bridging adjacent leads.

Component Modification Examples (continued)

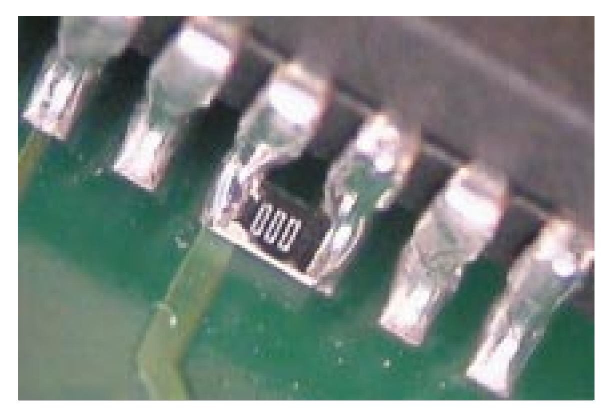


Figure 7 Chip component bridging leads of surface mount component.

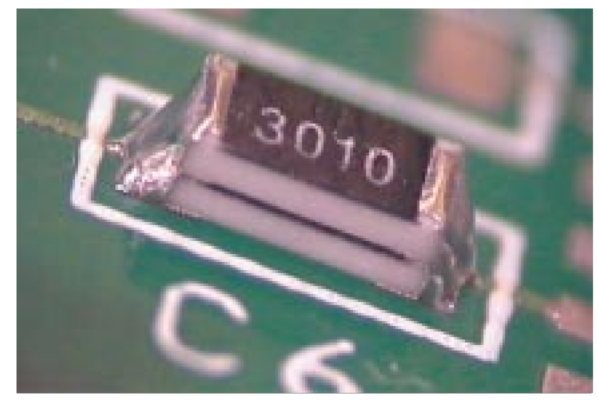


Figure 8 Chip component stacked onto another chip component.

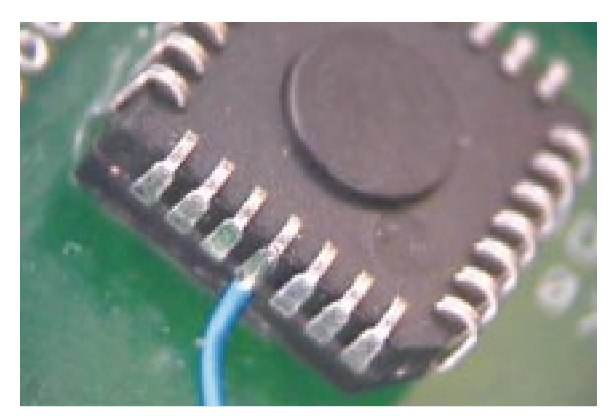


Figure 9 *Acceptable* Surface mount component mounted upside down with jumper wires attached. Note: One lead is bent outward.

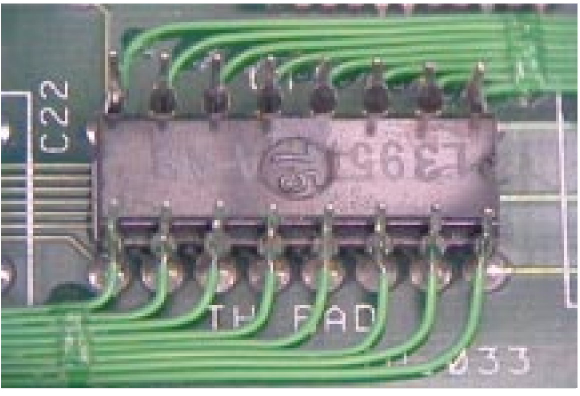


Figure 10 DIP component mounted upside down with jumper wires attached.

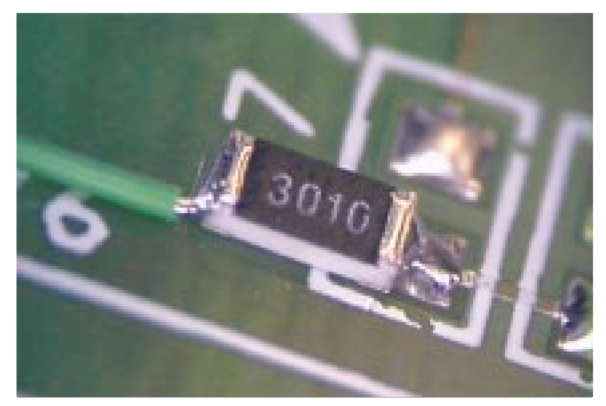


Figure 11 Chip component mounted to one pad only.



Figure 12 Radial lead component mounted upside down. Note: Insulate leads to avoid contact with component body.



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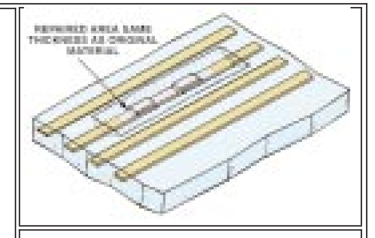
Repair and Modification of Printed Boards and Electronic Assemblies

Revision:

Date: **10/03**

Number: **7.1.1**

Flexible Conductor Repair



Product Class: F

Skill Level: Expert

Level of Conformance: Medium

OUTLINE

This method is used to replace damaged or missing conductors on the flexible printed wiring surface.

CAUTION

Flexible laminates come in a variety of materials, e.g., Mylar®, Teflon®, and Kapton®. These laminates are easily damaged during repair, if correct procedures are not used.

REFERENCES

2.1 Handling Electronic Assemblies
2.2 Cleaning

TOOLS & MATERIALS

- Dental Mixing Slab
- Scalpel Blade
- Pumice Impregnated Wheel
- Dental Tool (Carver)
- Dental Tool (Chisel)
- Soldering Iron
- Isopropyl Alcohol
- Acid Brush
- Oven
- Scalpel
- Microscope
- Rotary Bristle Brush
- Tweezers
- Orangewood Stick
- Soldering Iron Tip
- Lint-Free Tissue
- Silicone Resin
- Amber Colored Polyimide Film

PROCEDURE

1. After the damaged area has been isolated, mark the area of the laminate that is to be removed.

   NOTE
   Only enough laminate should be removed to expose the needed work area.

2. Support the flexible laminate with a flat, smooth surface such as a dental mixing slab or a piece of stainless steel. A firm base will keep the assembly from moving while repairing the damaged area.

   WARNING
   Do not apply lateral pressure to the scalpel. The blade could snap and cause personal injury.

   To ensure personnel safety and prevent workpiece damage, spot tools under the microscope in the work area before looking through the microscope.

   CAUTION
   Excessive pressure with a removal tool can cause additional damage to the laminate.

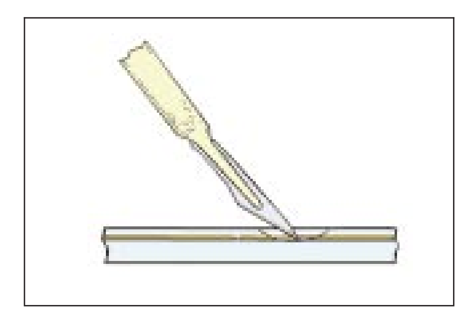


Figure 1 Laminate removal.

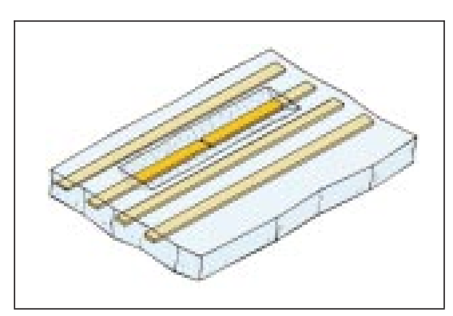


Figure 2 Laminate removed.

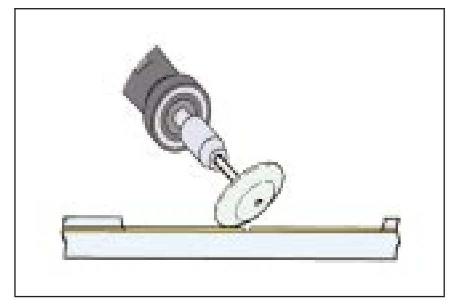


Figure 3 Adhesive removal.

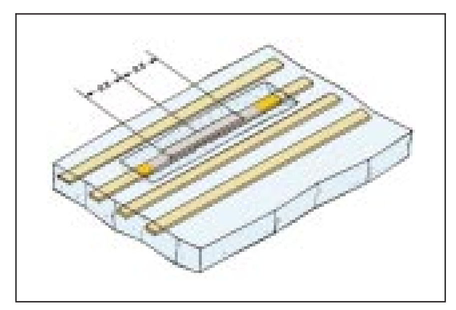


Figure 4 Conductor hairline crack repair.

3. Remove the laminate around the damaged conductor by working on the thinnest side of the flexible conductor. Laminate can be removed by using a light abrasive such as a pumice-impregnated wheel or rotary bristle brush. Removal may also be accomplished by cutting with a scalpel or dental tool. (See Figure 1.)

   NOTE
   Placing the microscope at an angle of 10°-30° to the flexible laminate may aid in determining the depth of the laminate removal.

4. Cut the laminate at a 45° angle along the bottom edge of the damaged conductor. Ends of laminate should be cut out at a 90° angle perpendicular to the conductor. The length of the laminate removed shall allow a minimum of 1/2 inch (1.3 cm) overlap on both sides of the damaged conductor area plus room for the end fillets on both sides of the replacement conductor. (Laminate Removal = Damaged Area + End Fillets + 1 inch (2.5 cm).) (See Figure 2.)
5. In many instances an adhesive will be coated onto the conductors. This must also be removed from the area where the replacement conductor is going to overlap the original conductor. The adhesive can be removed using light abrasion such as an ink eraser or rotary bristle brush or abrasive wheel. (See Figure 3.)
6. If conductor is not damaged and only the laminate requires replacement, proceed to step 18.
7. Once the laminate has been removed, the method of repair must be determined.
8. For a hairline crack, the repair will consist of a lap replacement with no original conductor material removed. (See Figure 4.)
9. For more extensive damage, the damaged conductor will have to be removed and a replacement conductor lap soldered in place. Any damaged portions of the conductor shall be removed using the following method:

   CAUTION
   Exercise care when using a scalpel and tweezers to prevent damage to an adjacent conductor.

10. Using a scalpel or dental chisel, bevel cut the conductor approximately 45° just outside the damaged area on both sides. (In order to have at least 1/2 inch (1.3 cm) of original conductor exposed, additional laminate material may have to be removed on both sides).
11. Grasp the damaged conductor with tweezers and remove. (See Figure 5.)
12. Obtain a replacement conductor equal to or slightly greater in width and thickness and a minimum of 1 inch (2.5 cm) longer than the removed damaged conductor. (See Figure 6 top.)

    NOTE
    All adhesive must be removed from the replacement conductor to ensure good wetting action.

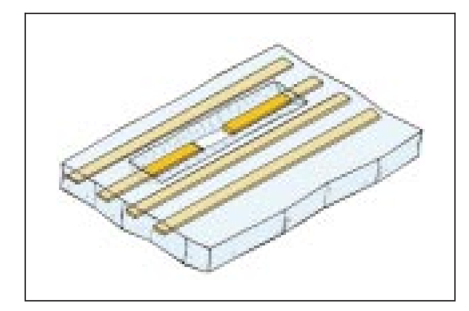


Figure 5 Beveling.

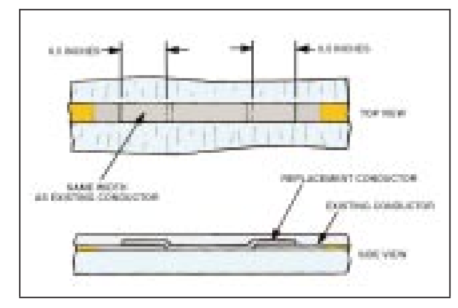


Figure 6 Replacement specifications.

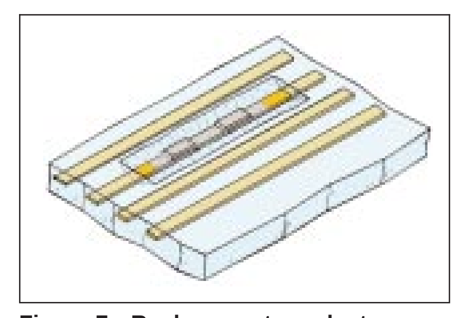


Figure 7 Replacement conductor soldered.

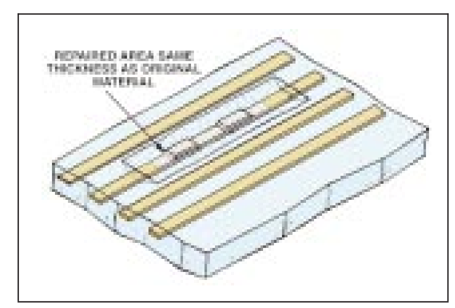


Figure 8 Repair encapsulated.

13. Clean replacement and form conductor in place. (See Figure 6 bottom.)

    CAUTION

    Avoid applying excessive heat to conductors. The laminate surrounding the repair area may melt. Place a wet lint-free tissue under the laminate to help dissipate heat while tinning and soldering the conductor.

14. Lightly tin the beveled ends and slightly beyond the overlap areas on each side of the existing conductor.
15. Tin the bottom of the replacement conductor in the overlap areas. The replacement conductor shall overlap the original area 1/2 inch (1.3 cm) minimum on each side of the damaged area to allow for flexing of the circuit.
16. Position the replacement conductor and solder in place. Using extremely light pressure with the soldering iron tip, follow along with a tool such as an orangewood stick, toothpick, or dental tool to hold the conductor down. (See Figure 7.)
17. After soldering, all flux residue must be removed with alcohol and a lint free tissue or an acid brush.

    CAUTION

    Do not allow the alcohol to air dry, as it will leave a thin layer of flux residue.

18. After completing the conductor repair, the insulating layer of laminate that was removed must be replaced. The most reliable method of laminate repair is to reapply a thin coating of the same type used by the manufacturer. If the same type of coating is not available, the following alternate procedures may be used.
19. To achieve reliable bonding of the coating, the laminate surface must be roughened in the repair area with an abrasive cloth or ink eraser.
20. Clean the repair area thoroughly with alcohol.
21. Remove moisture by drying flexible printed wiring in a curing oven at 130°F (54°C) for a minimum of one hour.

    CAUTION

    Read manufacturer's warning labels and instructions. Follow all safety requirements and procedures while handling Silicone Resin.

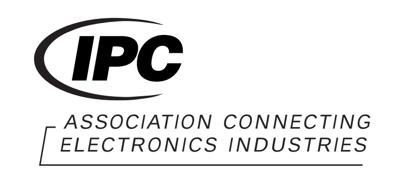
22. Apply the coating with a dental tool to bring the level of the repair area to the level of the original laminate. Feather the coating out on the sides of the repair approximately 1/4 inch (0.64 cm). Air bubbles or voids should not exceed 25% of the conductor spacing.
23. Cure following manufacturer's specifications.
24. Clean the area with alcohol and an acid brush to remove any remaining debris and residues. Inspect completed work.
25. If silicon adhesive is unavailable, polyimide tape may be used as a temporary substitute.

26. Cut a piece of polyimide tape to cover both sides of the repair area. The size should allow for a 1/4 inch (0.64 cm) overlap on the laminate. The overlap is measured from the edge of the repair area. Round the corners of the tape with a scalpel or scissors before applying tape to laminate. Do not stretch the tape.

    CAUTION

    Before applying polyimide tape, ensure that the assembly is free from all debris and residues that would interfere with the polyimide tape bonding to the repair area. Abrasion may be necessary if the surface of the laminate is slick and smooth. Abrasion will promote greater adhesion of the replacement tape.

27. Place the polyimide tape, adhesive side next to the conductor, over the repair area.



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Committee 2-30

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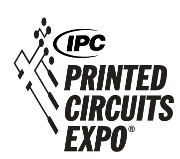
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Site General Manager____

Name Title

❑ EMSI COMPANY - Independent Electronics Assembly

This facility assembles printed wiring boards, on a contract basis, and may offer other electronic interconnection products for sale.

Site General Manager____

Name Title

❑ OEM - Original Equipment Manufacturer

This facility purchases and/or manufactures printed wiring boards or other interconnection products for use in a final product, which we manufacture and sell.

What is your company's primary product line?

____

Site General Manager ____

Name Title

❑ INDUSTRY SUPPLIER

This facility supplies raw materials, machinery, equipment, or services used in the manufacture or assembly of electronic interconnection products.

What products or services does your company supply? (50 word limit, please)
The information that you provide here will appear in the next edition of the IPC Membership Directory.

Our company supplies:

____

____

____

____

❑ GOVERNMENT AGENCY/ACADEMIC TECHNICAL LIAISON

This government agency or accredited university, college or technical training school is directly concerned with design, research and utilization of electronic interconnection devices. (Must be a non-profit or not-for-profit organization.)

Please proceed to page 2 to complete the membership application.

Application for IPC Site Membership



Site Information: (Please print or type)

Company Name

Street Address

City | State | Zip/Postal Code | Country

Main Switchboard Phone No | Main Fax No.

Company E-Mail Address | Website URL

Name of Primary Contact for all IPC matters | Title | Mail Stop

Phone No. | Fax No | E-Mail

Name of Senior Management Contact: | Title: | Mail Stop

Phone No | Fax No | E-Mail

Please attach business card of primary contact here.

Please designate your site's Technical Representatives:

For PWB/PWA design-related information and activities:

Contact Name | Title | Phone | Fax | E-mail

For PCB fabrication-related information and activities:

Contact Name | Title | Phone | Fax | E-mail

For Electronics Assembly-related information and activities:

Contact Name | Title | Phone | Fax | E-mail

Please designate your site's Management Representatives:

For PWB/PWA design-related information and activities:

Contact Name | Title | Phone | Fax | E-mail

For PCB fabrication-related information and activities:

Contact Name | Title | Phone | Fax | E-mail

For Electronics Assembly-related information and activities:

Contact Name | Title | Phone | Fax | E-mail

Please proceed to page 3 to complete the membership application.

Application for IPC Site Membership



MEMBERSHIP DUES SCHEDULE

Please check one:

❑ **$1,000.00 –** Annual dues for Primary Site Membership
Twelve months of IPC membership begins from the time the application and payment are received at the IPC office.

❑ **$800.00 –** Annual dues for Additional Facility Membership
An additional membership for a site within an organization where there already is a current Primary Site IPC membership.

❑ **$600.00** –** Annual dues for an independent PCB/PWA fabricator or independent EMSI provider with annual sales of less than $1,000,000.00. USD
** Please provide proof of annual sales.

❑ **$250.00 –** Annual dues for Government Agency or Academic Technical Liaison Membership. Must be not-for-profit organization.

TMRC MEMBERSHIP

❑ Please send information on participation in the Technology Market Research Council (TMRC) program. Only current IPC member sites are eligible to participate in this **calendar year** program, which is available for an additional fee.

❑ **Yes, sign up our site now:**

$950.00 - Primary TMRC member site

$400.00 - Additional facility TMRC member. Another site within our organization is already a TMRC program participant.

Name of Primary Contact for all TMRC matters:

____

Phone ______________ Fax ______________

E-Mail ______________________________

PAYMENT INFORMATION

Enclosed is our check/money order for $________________________

Mail application with check or money order to:

IPC
Dept. 77-3491
Chicago, IL 60678-3491

Fax or mail application with credit card payment to:

IPC
***2215 Sanders Road**
Northbrook, IL 60062-6135
Tel: 847-509-9700
Fax: 847-509-9798
**** Overnight deliveries to this address only***

Please bill my credit card (circle one) for $________________________

❑ MasterCard ❑ American Express ❑ Visa ❑ Diners Club

Account No ______________ Expiration Date ______________

Name of Card Holder ______________________________

Authorized Signature ______________________________

Phone Number ______________________________

QUESTIONS ?

Call the IPC Member Services Department in Northbrook, Illinois, at: 847-509-9700 (extensions 5309/5372)

or fax us at 847.509-9798

E-mail: JeanetteFerdman@ipc.org SusanStorck@ipc.org

Please proceed to page 4 to complete the membership application.

Application for IPC Site Membership



INFORMATION DISTRIBUTION

IPC has significant member benefits available to a wide range of individuals within your organization. To ensure that your facility takes advantage of these benefits, please provide the name of the individual responsible for each of the functional areas listed below. If one person has multiple responsibilities, please list that person's name as many times as necessary.

Chief Executive:

Name Title/Mail Stop Phone Fax E-mail

Sales/Marketing:

Name Title/Mail Stop Phone Fax E-mail

Finance (CFO)

Name Title/Mail Stop Phone Fax E-mail

Human Resources

Name Title/Mail Stop Phone Fax E-mail

Environmental/Safety

Name Title/Mail Stop Phone Fax E-mail

Design/Artwork

Name Title/Mail Stop Phone Fax E-mail

Product Assurance

Name Title/Mail Stop Phone Fax E-mail

Manufacturing

Name Title/Mail Stop Phone Fax E-mail

Training

Name Title/Mail Stop Phone Fax E-mail

Purchasing

Name Title/Mail Stop Phone Fax E-mail

IPC REVIEW SUBSCRIPTION LIST

One of the many benefits of IPC membership is a subscription to the IPC *Review,* our monthly magazine. Please list below the names of individuals who would benefit from receiving our magazine, which provides information about the industry, IPC news, and other items of interest. A subscription for the IPC Primary Contact person is entered automatically.

Name Title/Mail Stop

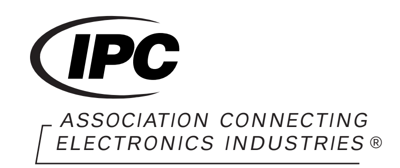
Name Title/Mail Stop

Name Title/Mail Stop

Name Title/Mail Stop

Name Title/Mail Stop

Name Title/Mail Stop



Standard Improvement Form

IPC-7711A/7721A

The purpose of this form is to provide the Technical Committee of IPC with input from the industry regarding usage of the subject standard.

Individuals or companies are invited to submit comments to IPC. All comments will be collected and dispersed to the appropriate committee(s).

If you can provide input, please complete this form and return to:

IPC
2215 Sanders Road
Northbrook, IL 60062-6135
Fax 847 509.9798

1. I recommend changes to the following:

___ Requirement, paragraph number __________

___ Test Method number __________, paragraph number __________

The referenced paragraph number has proven to be:

___ Unclear ___ Too Rigid ___ In Error

___ Other ______________________________

2. Recommendations for correction:

____

____

____

____

3. Other suggestions for document improvement:

____

____

____

____

Submitted by:

Name ______________________ Telephone ______________________

Company ______________________ E-mail ______________________

Address ______________________

City/State/Zip ______________________ Date ______________________



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